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SCIENCE 8

MODULE 2

CELLS AND SYSTEMS

Learning Technologies Branch

Alberta LEARNING

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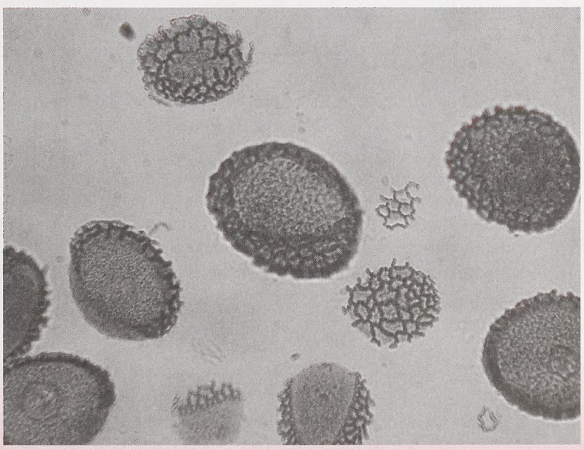
SCIENCE 8

CELLS AND SYSTEMS 2



Learning Technologies Branch

Alberta LEARNING

Science 8
Module 2: Cells and Systems
Student Module Booklet
Learning Technologies Branch
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The Learning Technologies Branch acknowledges with appreciation the Alberta Distance Learning Centre and Pembina Hills Regional Division No. 7 for their review of this Student Module Booklet.

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	
General Public	
Other	

You may find the following Internet sites useful:

- Alberta Learning, **http://www.learning.gov.ab.ca**
- Learning Technologies Branch, **http://www.learning.gov.ab.ca/ltb**
- Learning Resources Centre, **http://www.lrc.learning.gov.ab.ca**

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WELCOME

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Resources

Textbook

To complete the course, you need the textbook *ScienceFocus 8*.

Multimedia

Attached to Module 1 of this course is a CD titled *Science 8 Multimedia*. This CD contains multimedia segments designed to help you better understand particular concepts presented in this course. Ask your teacher or home instructor if you need help using this CD.

Materials and Apparatus

A list of materials and apparatus is given on page 10 of each Student Module Booklet. These items are needed to complete the module. Some of the materials and apparatus may be provided at your local school lab. If you don't have access to a school lab, you will need to get the loan kit. Talk to your teacher for more information.

Before You Begin

Organize your materials and work area before you begin: Student Module Booklet, textbook, notebook, pens, pencils, and so on. Make sure you have a quiet area in which to work, away from distractions.

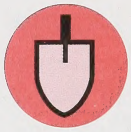
Because response lines are not provided in the Student Module Booklet, you'll need a looseleaf binder or notebook to respond to questions and complete charts. It's important to keep your lined paper handy as you work through the material and to keep your responses together in a notebook or binder for review purposes later.

Refer to the Planning Ahead page for directions on what you need to do before you start this module.

Good luck!

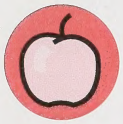
Icons

This is one of five Student Module Booklets for Science 8. As you progress through this module, you will meet several icons.



Do Ahead

Some preparation must be started well ahead of the activity or investigation. E.g., start the seedlings for the investigation in Lesson 3.



Teacher or Home Instructor

The teacher or home instructor should be contacted for help, approval of some procedure, or checking answers.

Assignment Booklet

Work needs to be done in an Assignment Booklet.

Safety

You must be very careful when you see this symbol.

Textbook

A reference is made to *ScienceFocus 8*, the student textbook for this distance learning course.

Internet

This is a reference to the Internet. **Note:** Any Internet website given is subject to change.

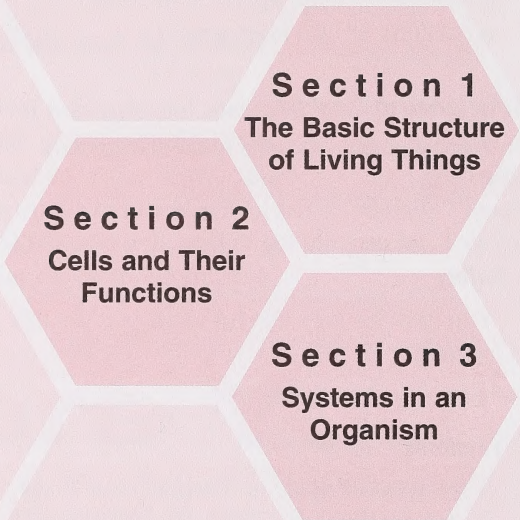
Multimedia

This is a reference to the *Science 8 Multimedia* CD.

Overview

Have you ever thought about the similarities between a bacterium, a plant, and an elephant?

Like you, they are all living things and must carry out life's basic functions: obtaining energy and nutrients, sensing and responding to environments, body growth and maintenance, waste elimination, and reproduction. To do these things you could expect these organisms to have a lot in common. Yet, there is such a diversity among plants, elephants, and tiny bacteria. How can such vastly different organisms be so basically similar?



The root of understanding starts with the basic unit of life—the cell—then grows as you discover how cells combine and co-ordinate to form living things with many cells.

In this module you will build both skills and knowledge as you travel through the microscopic world of single-celled organisms. You will examine increasingly higher levels of organization in organisms. This will take you to the complexity of your own body. During this journey of discovery you will investigate some of the technologies and research that contributed to the understanding of how cells, tissues, organs, and organ systems can work together to maintain the life and health of living things within their environment.

Check out the "Unit 2 Preview" on pages 96 and 97 of the textbook to discover where you will be going in Module 2.

Assessment

The booklet you are presently reading is the Student Module Booklet. It will show you, step by step, how to advance through Module 2: Cells and Systems.

This module, Cells and Systems, has three sections. Within each section your work is grouped into lessons. Within the lessons there are readings, investigations, activities, and questions for you to do. By completing these lessons you will discover scientific concepts and skills, develop a positive attitude toward science, and practise or apply what you have learned.

Suggested answers in the Appendix of this Student Module Booklet will provide you with immediate feedback on the answers to questions in the lesson. Your teacher or home instructor will also provide you with feedback on your progress through the module.

At several points in this module you will be directed to an accompanying Assignment Booklet. Your grading in this module is based on the assignments you submit for assessment. In this module you are expected to complete three section assignments and a Final Module Assignment.

The mark distribution is as follows:

Assignment Booklet 2A	
Section 1 Assignment	35 marks
Section 2 Assignment	30 marks
Assignment Booklet 2B	
Section 3 Assignment	34 marks
Final Module Assignment	16 marks
TOTAL	115 marks

Planning Ahead

Here is a list of materials and apparatus you will need to complete this module.

Section 1

- ❑ household bottles
- ❑ household flasks of various sizes
- ❑ a medicine dropper
- ❑ three microscope-slide cover slips
- ❑ three microscope slides
- ❑ a pair of scissors
- ❑ several small pieces of newspaper
- ❑ a transparent plastic ruler with millimetre markings
- ❑ tweezers, if possible
- ❑ various jars
- ❑ lens paper

You will need either Path A materials or Path B materials.

Path A

- ❑ a compound light microscope
- ❑ hay and, if possible, pond water
- ❑ a prepared microscope slide of human skin cells

Path B

- ❑ a micro-slide viewer
- ❑ micro-slide "set #58: Cell Structure"
- ❑ micro-slide "set #69: The Central Nervous System"
- ❑ micro-slide "set #119: Green Plants"
- ❑ micro-slide "set #222: The Kingdom Protista"

Section 2

- ❑ two uncooked eggs
- ❑ a 100-mL cylinder or a measuring cup
- ❑ a sharp knife or a single-edged razor
- ❑ a 15-mL measuring spoon or a tablespoon
- ❑ a tall, narrow drinking glass or jar
- ❑ distilled water, if possible
- ❑ red food colouring
- ❑ a spring scale and a plastic baggie or a triple-beam balance
- ❑ sweetened drink powder (e.g., iced tea, or a fruit-flavoured punch)
- ❑ two stalks of celery with leaves attached
- ❑ salt
- ❑ vinegar

Section 3

- ❑ a large plastic pop bottle
- ❑ modelling clay, bubble gum, or a non-toxic sealant
- ❑ two small balloons
- ❑ two plastic straws
- ❑ two elastic bands

In Section 1: Lesson 3, you will need to start a hay infusion. See the "Do Ahead" icon on page 28.

In Section 2: Lesson 1, you will need to place two uncooked eggs in vinegar a day before you do an investigation. See the "Do Ahead" icon on page 45.

If you have access to the Internet, you may want to check out some of the links for this module ahead of time. Go to the following site:

http://www.mcgrawhill.ca/school/booksites/sciencefocus+8/student+resources/toc/index.php

Section 1

The Basic Structure of Living Things

What is it that makes you alive? You are familiar with a wide variety of living things. Have you ever thought about what all organisms have in common? What makes them different from non-living things like rocks, air, metal, and water? What are the basic structures of life? How are they organized to carry out essential functions?

In this section you will build on your knowledge and experience to increase your understanding of the structures that provide the essential functions of life. Your technological skills will also be developed as you use a microscope or micro-slide viewer, prepare slides, and record observations.

Lesson 1: Living Organisms

Living things seem to differ so much in what they look like and what they do. This lesson focuses on living things and what they have in common. This lesson introduces you to characteristics that all living things share. All living things are made up of **cells**, the small basic units of life. Besides that, living things have five characteristics that relate to important things they do. To be classified as alive, living things must carry out all of five important **functions**.

cell: the smallest unit that can perform all the functions of life

function: an activity, a job, or a role

This lesson will also show how cells are arranged in large **organisms**, which are made up of many cells.

organisms: living things

Living or Non-Living

Think about the mushrooms, the glacier mummy, and the quartz crystals. Can you identify the living things?

alive: having all the characteristics of living things

The mushrooms are living things. You know the mushrooms are **alive**.

You know some crystals grow, but that still does not make them alive. The quartz crystals are non-living.

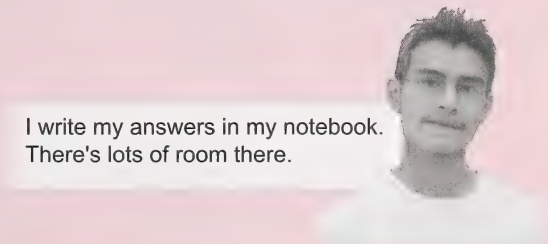
dead: once alive but no longer alive

You may hesitate as you look at the glacier mummy. The mummy looks like a life form because it's from a "living thing." But after a moment you decide it's not a living thing anymore. The mummy really is **dead**. That makes it non-living.

Dead things have some of the makeup of living things but no longer carry out all of the functions of living things.

For more information about the glacier mummy, use a search engine such as www.google.ca. Search with the words "Otzi" and "iceman."

In this lesson, and in the rest of this course, you will be doing written work. You will sometimes be directed to an Assignment Booklet to do this written work. However, for the numbered questions in Student Module Booklets, you should answer the questions in a notebook set aside for Science 8.



Also, use the notebook to record results while doing science investigations.

dormant: alive but not active or growing

Seeds, eggs, and bulbs may stay dormant in harsh conditions.

Now try the following question. Place your answer in your notebook. **Hint:** **Dormant** things are living things, too. Use the margin definitions to help you with the classification.

1. Which of these items are living things?

- spiders
- glacier mummies
- snowflakes
- dried flower bouquets
- daisies
- driftwood
- apple seeds
- air
- nail clippings
- petrified wood
- brain cells
- mushrooms
- rocks
- bacteria
- mushroom spores
- cakes
- quartz crystals

Compare your responses with those in the Appendix on page 79.

You already have a pretty good idea of what makes something living. But it will help if you know what characteristics living things have in common.

The Characteristics of Living Things

Have you ever played softball or baseball? To catch a fast-moving ball you have to react very quickly to put your ball glove in front of the ball and grasp it.

Did you know that some plants can also move quickly? When it's touched, a Venus flytrap can redistribute water within its cells to create movements that are fast enough to trap flies!

You are probably more familiar with the gradual responses of plants. As a plant grows, it responds gradually to gravity, light, chemicals, and water. If the light is stronger from one direction, the result can be faster cell growth on one side of the plant. The difference in cell growth causes the plant to bend and redirect its growth.

Living things respond—gradually or quickly—to changes in their environment. A thing responding to change is likely a sign that it is alive. But responding is not the only sign or characteristic associated with being alive.

Turn to the textbook. Read pages 98 and 99 to find out more about the characteristics of being alive, as well as related functions and **structures**.

structure: anything made up of parts arranged together

Note that non-living things include the following:

- dead things—the things that were alive but are no longer alive
- things that were never alive

In this module the focus is on living things. You will study how you can distinguish living things from non-living things.

Skim through all the textbook pictures from Unit 2. Answer the following questions in your notebook by using what you already know and the information in the textbook. Use appropriate scientific terms.

2. All living things are made of cells. Scientists agree that there are certain other characteristics common to living things. What are these other characteristics?

3. There are structures that living things need to obtain energy.

a. List three animal structures used for food gathering.
b. Name a plant structure used to make food.

4. Living things must respond to their internal and external environments to survive.

   a. List five structures animals use to sense changes in their environments.
   b. List two ways plants can move toward or away from something.

5. All organisms carry out five functions to stay alive. Which function is most closely related to all of the following items?

   - flowers
   - calves
   - seeds
   - puppies
   - spores

6. Living things must get rid of waste.

   a. What are three types of waste produced by animals?
   b. What type of waste is produced by plants?

Compare your responses with those in the Appendix on page 79.

Going Further

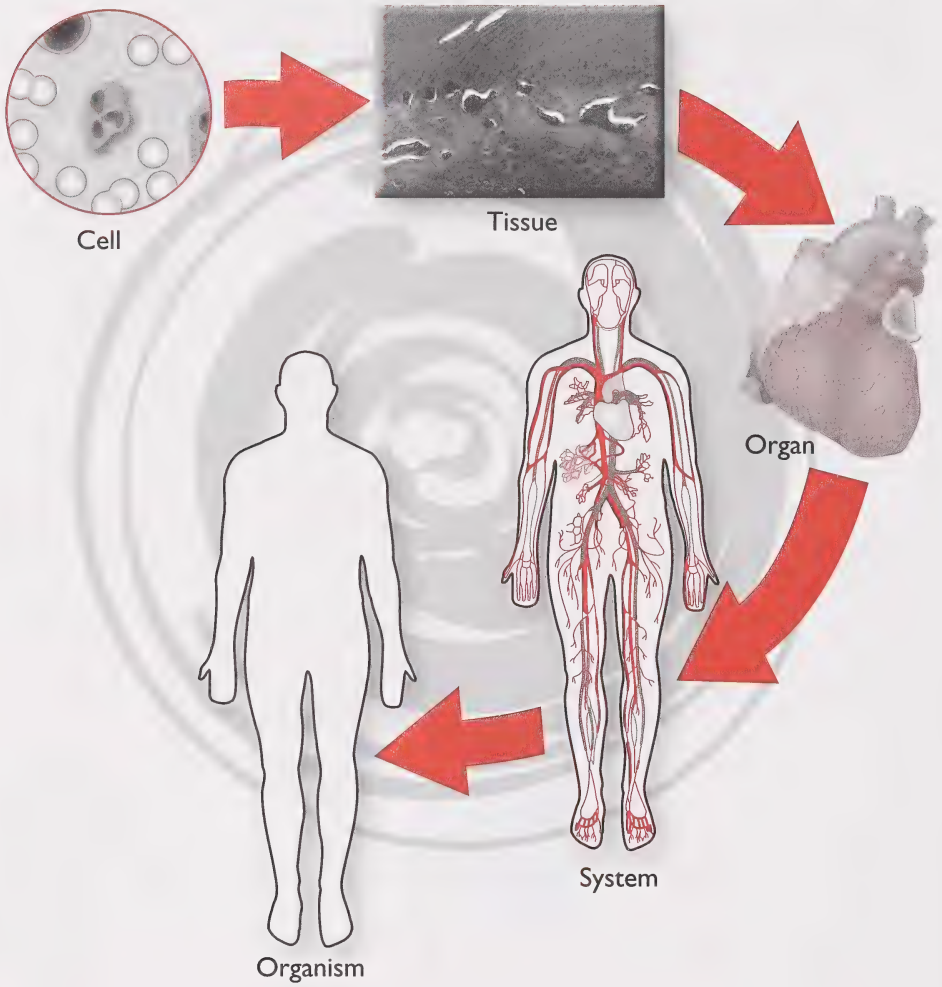
Do all organisms do the same basic things?

That's impossible. They're too different!

Turn to the textbook and do the "Find Out Activity: Functions and Structures" on page 99. You will discover if all organisms do the same things.

Think about jellyfish, paramecium, plants, insects, earthworms, frogs, and cats. How is it possible for vastly different organisms to do the same functions? If you're working on your own you may want to share your findings with a family member or a friend.

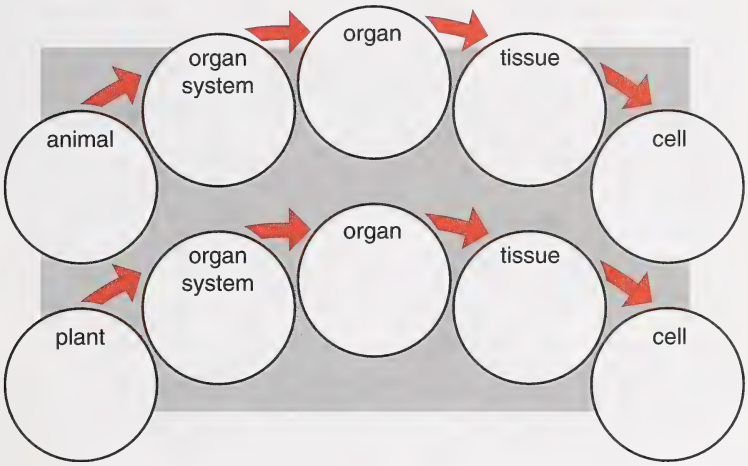
Levels of Organization in Organisms



The basic unit of all living things is the cell. Some organisms are very small and are made up of just one cell. (They are said to be unicellular.) Other, larger organisms are composed of many cells. (They are multicellular.) When you think of a cell, you are focusing on the lowest level of organization in organisms. What are the other levels of organization?

Read pages 100 to 102 in the textbook to find out the levels.

7. Copy two event chain maps or flowcharts, like the following ones, and name or sketch appropriate examples in each bubble. Make sure the bubbles are large enough for your sketch.



8. Turn to page 102 of the textbook. Answer question 4 from "Topic 1 Review."

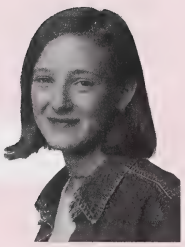
Check your answers with your teacher or home instructor.

Going Further

Do you want to know about scientific studies in Alberta? Then follow the "Internet Connect" on page 101 of the textbook. You will learn that the study of living things takes place not only in laboratories, but in the organisms' environments as well. Scientists study animal and plant populations through a wide variety of research projects.

These "Going Further" sections are for those of you who want to do extra in-depth work. There are lots of interesting topics to work on.

Going Further



This "Going Further" prepares you for "Design Your Own Investigation: Responding to Changes" on page 166 of the textbook.

Read "Looking Ahead" on page 97 of the textbook. Follow the directions and start planning. Create an Investigation Planning File. Write down any questions that you would like to investigate as you work through the module. How can you communicate your research and investigations to your instructor, friends, or family? Keep your eyes open for the other "Looking Ahead" tips as you work through this unit.

Looking Back

In this lesson you described characteristics of living things and related their structures to their functions. You saw how cells make up the basic unit of life, and you discovered that individual cells carry out functions like that of multicellular organisms. As well, you viewed the makeup of organisms according to different levels of organization—cells, tissues, organs, and systems.

Turn to Assignment Booklet 2A. Complete questions 1 to 6 from Section 1.

Lesson 2: Microscopes and Cells

Did you know that tiny bacteria live at the base of your eyelashes? These tiny organisms eat materials deposited by your tears. Until the 1600s not much was observed of organisms on the scale of bacteria.

In a sense, Anton van Leeuwenhoek (1632–1723) opened the portal—or door—to the world inhabited by bacteria. He was one of the first people to build and use **microscopes** to study this world. He observed and calculated the size of bacteria and gave the first accurate description of red blood cells. His discoveries led other scientists to look into this new world. Progress in medicine soon followed.

microscope: an instrument used to magnify structures not visible to the naked eye

Modern technology has widened the opening into this important and awe-inspiring world. In fact, with the new synchrotron in Saskatoon, scientists can see the individual particles that make up matter. This synchrotron is the size of a football stadium and cost $174 million to build. It's useful in almost every branch of science.

This lesson focuses on the microscope and the discovery of cells. Hands-on investigations then allow you to peek through the mysterious doorway as you develop your own microscope skills.

A Magnifying Experience

magnifying: making an object appear larger

Why do people wear glasses or use **magnifying** glasses? To see what they could not see or could not see clearly, of course! In other words, to enhance their eyesight. Our eyes are limited in their ability to see. If you look at two small dots that are less than 0.1 mm or 100 micrometres apart, they will look like one dot. Most micro-organisms are less than 30 micrometres in diameter—this is well below the viewing power of the human eye.

Turn to page 103 of the textbook. Read the top half of the page and look at the circles of dots. Then try to answer the questions in the textbook that relate to the dots. Even the colours that look solid are made up of dots.

Find Out Activity: What Does It Take to Enlarge an Object?

Refer to the activity on page 103 of the textbook.

Follow the steps of "Procedure."

1. Complete questions 1 and 2 from "What Did You Find Out?"

Check your answers with your teacher or home instructor.

Use a macroscopic scale—a scale for things visible to the naked eye—to see how an object changes with magnification.

Draw a 1 cm square in the centre of a large sheet of paper or on several sheets of paper taped together. Draw a 10 cm square around it and a 40 cm square around the 10 cm square. Under the 1 cm square write "the object," under the second square write "the object magnified 10X," and under the third square write "the object magnified 40X." Continue the process with further magnifications if you like. Now you can "see" how magnification works on a macroscopic level.

Microscopic History

magnification: the amount an object has been enlarged

Anton van Leeuwenhoek was the first person to peer into the world of micro-organisms. He used microscopes with a **magnification** of up to 300 times. Where has the development of the microscope led?

Read pages 104 and 105 of the textbook to find the answer. Then use the information to answer the following questions.

2. Answer questions 3 and 4 of "Topic 2 Review" on page 114 of the textbook.

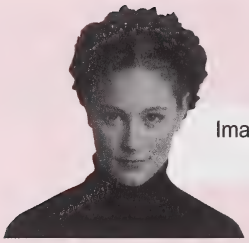
3. The development of the microscope contributed to the understanding of living things.

a. What did scientists find in every plant, animal, and micro-organism they examined?

b. Why did Schleiden and Schwann hypothesize that the cell is the basic unit of life?

Compare your responses with those in the Appendix on page 80.

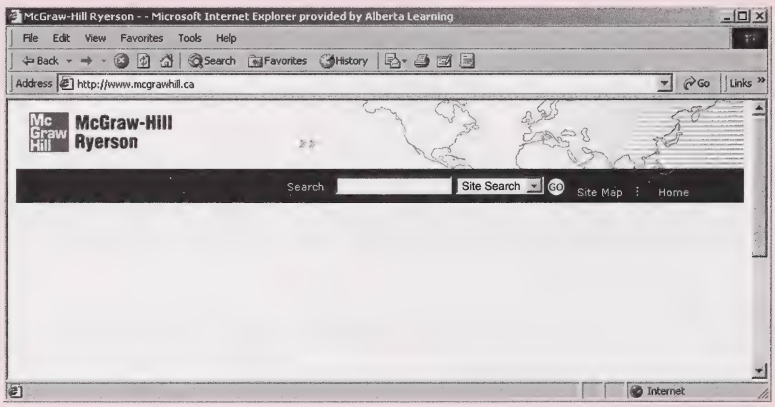
Going Further



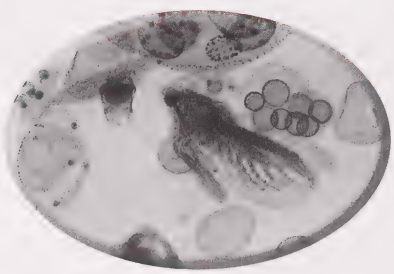
Imagine that — van Leeuwenhoek was a cloth merchant!

Go to a search engine, such as Google ™. Use the expressions *van Leeuwenhoek*, *microscope*, *modern,* or *history* to find out more about the development of the microscope, the lives of those people who built or used them, and current microscope technology. You could use a timeline to indicate when improvements to the microscope happened. Maybe you would like to report on how ideas about disease changed because of the microscope.

You can also do a site search on the textbook publisher's website at **www.mcgrawhill.ca**. Follow the appropriate links to information about Anton van Leeuwenhoek.



Using a Microscope or a Micro-Slide Viewer



In the next investigation, if you have a compound light microscope, you will get a chance to try it out. If you don't have access to a microscope, you will explore the world of the miniature by using micro-slide viewer slides.

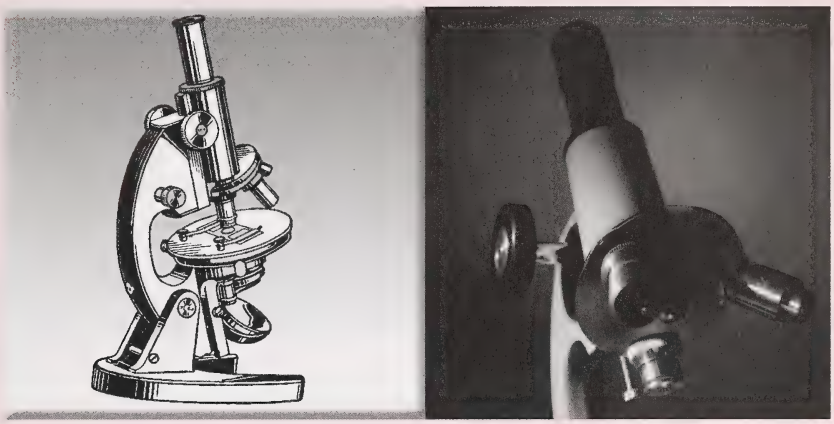
Investigation 2A Using a Microscope

Refer to the "Inquiry Investigation" on pages 106 to 111 of the textbook. There are three parts to it.

Part 1

The Compound Light Microscope

Refer to Part 1 on page 106 of the textbook.



The compound light microscope magnifies an image by bending the light rays coming from the specimen into a larger visual area. It is made with more than one lens and uses light to view specimens. Lenses of different shapes and thicknesses bend the light rays in a variety of ways—this allows you to choose how you view a specimen.

Microscopes are used in many areas of science and technology. It can be useful to be able to clearly communicate about their parts. Do Step 1 of "Procedure."

4. Turn to "Skill Focus 11" on page 520 of the textbook. Read the introduction and the section titled "Making a Scientific Drawing." Use the directions to create a diagram of the microscope pictured on page 107 of the textbook. Identify the parts of the compound light microscope on your diagram.

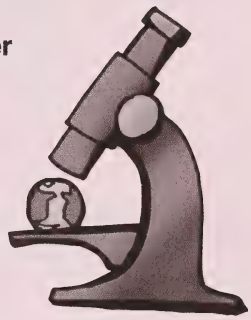
5. Read page 513 of "Skill Focus 10." Use a computer, or a pencil and ruler, to create a two-column data table. The table is to be used for information about the parts of a microscope, and what the parts are used for. Give the table an appropriate title. Label the first column "Parts" and the second column "Function." Use the information on pages 106 and 107 of the textbook to fill in your data table. Be sure to plan ahead. How many rows do you need? How much space do you need in each row? How wide do the columns need to be?

Check your answers with your teacher or home instructor.

Part 2

Using Your Microscope or Micro-Slide Viewer

Refer to Part 2 on pages 108 and 109 of the textbook.



Now that you are familiar with the parts of a compound light microscope, you can peek through the mysterious doorway yourself. Use either a microscope or a micro-slide viewer.

Pathways

For this investigation, and the ones that follow in this lesson and in Lesson 3, consistently follow "Path A" if you have access to prepared microscope slides and the type of compound light microscope pictured on page 107 of the textbook.

Otherwise, follow "Path B." This requires the use of a micro-slide viewer and micro-slides.

Path A

6. Follow the steps of "Procedure" on pages 108 and 109. Read and follow each direction very carefully in the order it is given to ensure that you are not hurt and that the slide and the microscope are not damaged. Record your observations for steps 3(d) and 4 in your notebook.

7. Answer questions 2 to 4 and 6 from "Analyze" and "Conclude and Apply" on page 111 of the textbook.

Path B

Read, then follow, the directions printed on the micro-slide envelope in one of the micro-slide booklets. Handle the slides by the edges only to keep them clean.

Note: Always return the micro-slides to their envelopes after viewing them.

8. Do step 4(a) of "Procedure" on page 109 of the textbook. View the scalp bacteria on micro-slide #7 of set #58: "Cell Structure." Record your observations in your notebook.

9. Record the magnification of the specimen. **Note:** The magnification of each micro-slide is shown in the micro-slide booklet. No calculation is involved. On the other hand, if you had a compound microscope you would have to do a simple calculation to determine the magnification. You would multiply the power of the objective lens and the power of the eyepiece.

Check your answers with your teacher or home instructor.

Part 3

Measuring the Field of View

Refer to Part 3 on pages 110 and 111 of the textbook.

Knowing the diameter of the field of view gives you an idea how large the object you are looking at really is. For example, if you know that the field of view has a diameter of 2 mm and the micro-organism you are looking at fills half of the field, you can deduce that the organism is 1 mm across. Follow these directions to try it out for yourself.

Path A

10. Carefully read and follow the steps of "Procedure" on page 110 of the textbook. Sketch the view through the microscope and indicate the field of view.

11. Refer to "How to Calculate the Field of View" on page 111. Do the "Conclude and Apply" questions from 7 to 9 on page 111.

Path B

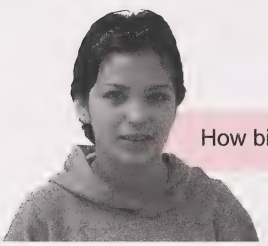
12. Use the textbook field-of-view diagram and its caption on page 110 to help you answer this question.

a. Place a clear plastic ruler into the slot in the micro-slide viewer. Determine and record the diameter of the field of view in millimetres (mm).

b. How long is an object that goes halfway across your field of view?

13. As the magnification power gets higher, the field of view gets smaller. Try to explain this statement.

Check your answers with your teacher or home instructor.



How big are they really?

Do some math to help you use micrometres to indicate the size of the micro-organisms that you just looked at.

14. Try "Math Connect" on page 111 of the textbook.

Compare your responses with those in the Appendix on page 80.

The final investigation in this lesson involves making your own wet mount slides.

Investigation 2B Preparing a Wet Mount

Refer to the "Inquiry Investigation" on pages 112 and 113 of the textbook.

Prepared slides are very interesting, especially when they have been stained. The stains highlight or reveal structures that would otherwise be hard to see. Preparing your own slides can be fun, too. And the results are equally interesting. Give it a try in this investigation.

Pathways

Reminder: Follow "Path A" if you have access to a compound light microscope. Otherwise, follow "Path B."

Path A

wet mount: a slide prepared using water and a cover slip

Follow the "Procedure" to prepare and observe your **wet mount** slide. Be sure to read the "Troubleshooting" comments.

15. Do questions 1 to 4 of "Analyze."

Path B

Follow steps 1 to 3 of "Procedure" on page 112 of the textbook to prepare your wet mount slide. Be sure to read the "Troubleshooting" comments on page 113. Then view the slide by using your micro-slide viewer. When a wet mount slide is in the micro-slide viewer, hold the viewer in your hand. Keep the viewer tipped forward so that your slide remains level.

16. Do question 4 from "Analyze."

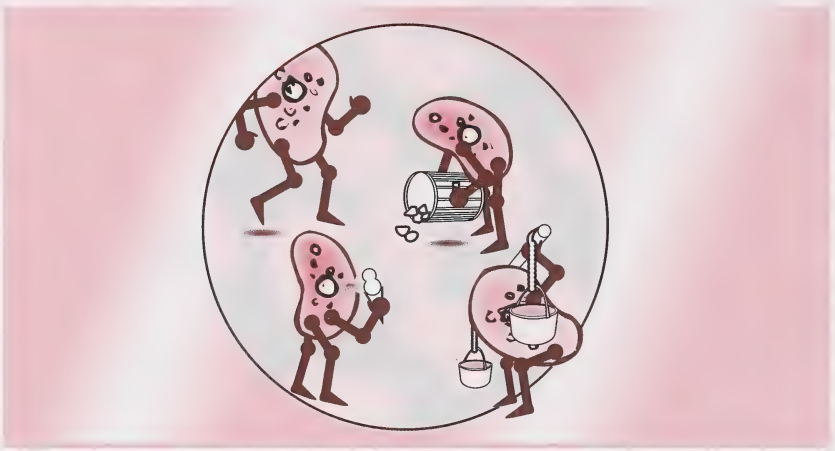
Check your answers with your teacher or home instructor.

Looking Back

In this lesson you looked back on the development of the microscope and considered how this technology influenced science. You used a microscope or a micro-slide viewer to make your own observations.

Turn to Assignment Booklet 2A. Complete questions 7 to 10 from Section 1.

Lesson 3: The Cell and Its Structures



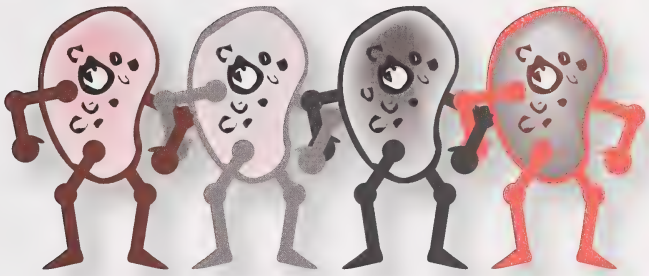
Hay Infusion

If you have access to a compound light microscope, you will need to start a hay infusion about one week before you do this lesson.

It's easy. Place a handful of dry hay, straw, slough grass, or weeds in a jar. Add about two cups of room temperature water. Place the jar in sunlight. Do not cover the jar. Add water as needed for evaporation losses.

Cells are not just the basic building blocks of life. All the general functions or activities carried out by complex multicellular organisms are also carried out by each of the organism's cells. Each cell must also have the necessary structures to make these functions possible.

What are these related structures and functions at the cellular level? Cells must have structures to obtain and use energy and to remove wastes. Cells must also have structures to move substances. And cells must have structures to respond to environmental factors, such as temperature, water availability, and the presence of poisons. Other structures are required for reproduction.



multicellular: composed of more than one cell

Of course, the various cells of a **multicellular** organism must perform their jobs as part of a team. Teamwork and co-operation are needed for the organism to both perform its functions and survive. The cells cannot be just doing their own thing—they must work hand in hand.

unicellular: composed of one cell

Since **unicellular** organisms are cells, they must perform the same functions as any other cells to survive. However, because they are separate living things, unicellular organisms can be more independent.

In this lesson you will look more closely at the basic structures within plant and animal cells. You will be introduced to the many similarities that cells share. You will begin to appreciate the vast diversity of cells—some specialized for a particular function within a multicellular organism, and other cells existing as individual unicellular organisms.

Skill development continues as you prepare slides, use a microscope or micro-slide viewer to examine a variety of cells, and record your observations.

Unicellular and Multicellular Organisms

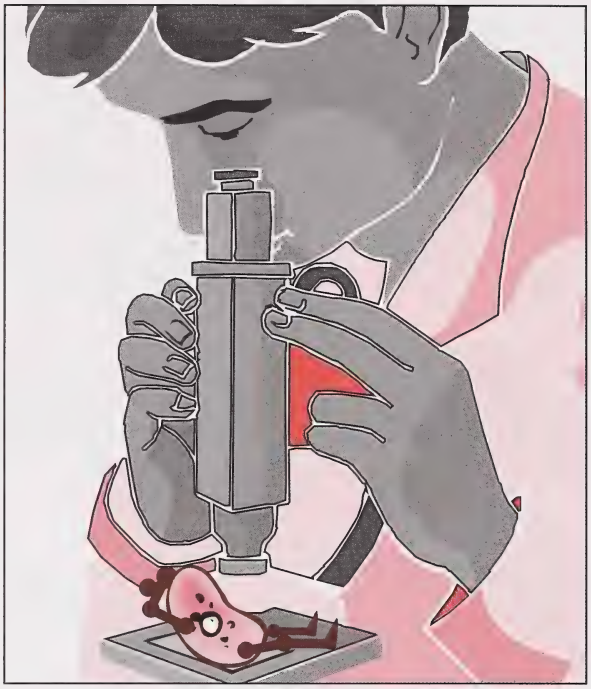
You will now examine several microscopic organisms in greater detail by using the skills you acquired in Lesson 2.

Read the information, note the magnifications, and closely examine the photos on page 115 of the textbook. Also read the top half of page 117. You may find some of these organisms in the water from your hay infusion or included on your micro-slides.

Carefully read "Skill Focus 11: Scientific and Technological Drawing" on pages 520 and 521 of the textbook. Use this information when you create diagrams of the micro-organisms that you observe.

Through the Portal

Finally, you get to view entire microscopic organisms. If you have access to a microscope and you have prepared a hay infusion, you will be viewing live, unstained organisms. Although many of these organisms will be unicellular, it is likely that multicellular organisms will also be present! Use the micro-slide viewer to see dead organisms. These are stained in such a way that the tiny structures of their "bodies" become easier to see.



Investigation 2C Pond Water Safari

Refer to the "Inquiry Investigation" on pages 116 and 117 of the textbook.

Pathways

Reminder: Follow "Path A" if you have access to a compound light microscope. Otherwise, follow "Path B."

Path A

Use the water from your hay infusion and also use pond water if you can obtain it. If you use both examples of water, you are likely to observe a greater variety of organisms.

You should examine several different drops of water. Gently stir the water to get micro-organisms from a variety of areas within the container.

1. Follow the steps of "Procedure." In step 4, label as many cellular structures as you can. If possible, use micro-slide set #222: "The Kingdom Protista," and its booklet as a reference.

2. Do questions 1 to 6 on page 117 of the textbook.

Path B

Note: Remember to store the micro-slides in their envelopes after viewing them.

Read, then follow, the directions printed on the micro-slide envelope in one of the micro-slide booklets. Handle the slides by the edges only to keep them clean.

3. View micro-slide set #222: " The Kingdom Protista," with your micro-slide viewer. Draw and label two or three of these organisms—include their magnifications. Refer to the slide information in the booklet.

4. **a.** How are the organisms similar?

   b. List the structures you observed that allow these organisms to move.

   c. List the structures you observed that allow these organisms to take in or produce food.

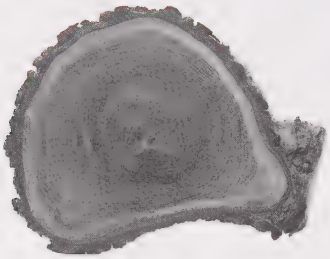
   d. How do you think a multicellular organism would differ from a unicellular organism? How would they be similar?

Check your answers with your teacher or home instructor.

5. Answer questions 1 and 3 from "Topic 3 Review" on page 126.

Compare your responses with those in the Appendix on page 81.

Comparing the Cells of Plants and Animals



Do plant and animal cells differ in any significant ways? If you were looking at an unidentified cell or tissue under a microscope, could you tell whether it was a plant or an animal specimen? Did you know that cells have organelles that are comparable to the organs found in multicellular organisms? And, did you know that each of these organelles has a characteristic structure and carries out the same function in every cell it is found in? You will investigate these features yourself.

Read pages 121 to 123 of the textbook. This important information will help you accurately observe the cells and tissue in the next investigation.

6. Write a definition for each of the following terms.

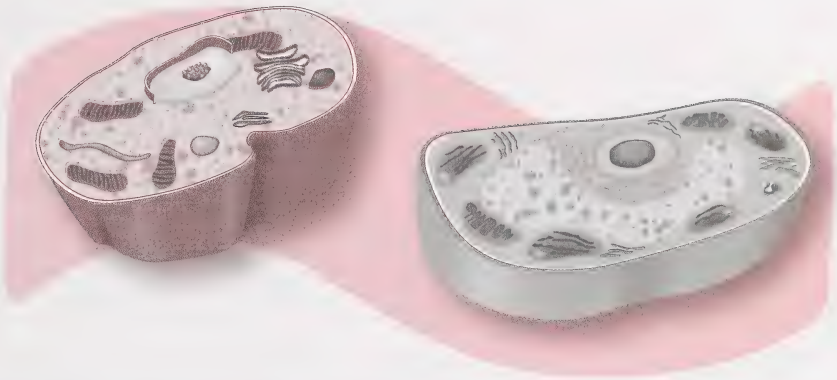
a. organelles
b. cell membrane
c. cytoplasm
d. nucleus
e. vacuole
f. cell wall
g. cellulose
h. chloroplasts

7. Where is energy produced in cells?

8. What cell structure are you looking at when you view bark under a microscope?

9. What parts of a tree are alive?

Compare your responses with those in the Appendix on page 81.



Investigation 2D Observing Plant and Animal Cells

Refer to the "Inquiry Investigation" on pages 118 to 120 of the textbook.

Pathways

Reminder: Follow "Path A" if you have access to a compound light microscope. Otherwise, follow "Path B."

Path A

10. Read all the information of "Part 1: Observing Plant Cells." Then follow the "Procedure." For step 4, you may use water again instead of iodine solution. Clearly draw and label any organelles that you see. Include the total magnification.

11. Read "Part 2: Observing Animal Cells." Then follow the "Procedure." If a prepared slide is not available, use the micro-slide viewer to view slide 4 of micro-slide set #58: "Cell Structure." Clearly draw and label any organelles that you see. Include the total magnification.

Check your answers with your teacher or home instructor.

12. Do questions 1 to 4 of "Analyze" and "Conclude and Apply" on page 120 of the textbook.

Compare your responses with those in the Appendix on page 82.

Path B

For a survey of some plant cells, view micro-slides 1 and 2 of set #58: "Cell Structure," and micro-slide 7 of set #119: " Green Plants," with your micro-slide viewer.

13. Clearly draw and label cells from the onion skin. This is on micro-slide 2 of set #58. Also draw any organelles that you see. Include the magnification. Refer to the slide information in the booklet.

For a survey of some animal cells, view micro-slides 4 to 6 of set #58 and slide 6 of set #69: "The Central Nervous System," with your micro-slide viewer.

14. Draw some red blood cells. Include the magnification. Refer to the slide information in the booklet.

Check your answers with your teacher or home instructor.

15. Do questions 2 to 4 of "Analyze" and "Conclude and Apply" on page 120 of the textbook.

Compare your responses with those in the Appendix on page 83.

16. Answer questions 4 to 6 and question 8 in "Topic 3 Review" on page 126.

Compare your responses with those in the Appendix on page 83.

Going Further

Try the "Problem-Solving Investigation 2E: Build Your Own 3-D Cell," on page 124 of the textbook.

Check out a virtual cell. Follow the directions in the "Internet Connect" on page 124.

Cell Size and Function

Note: 1 µm equals 0.001 mm.

With a diameter varying from 10 cm to 15 cm, the ostrich egg is the world's largest single cell. The smallest single-celled organism discovered so far measures a few thousand atomic diameters. The average adult human body is made up of 100 trillion cells. Most cells range in size from 10 to 30 µm.

Use your imagination as you read all the information on pages 125 and 126 of the textbook. Then answer the following questions.

17. Do question 7 from "Topic 3 Review" on page 126 of the textbook.

18. Create a data table like the following one. Fill in the empty spaces with terms that are listed following this table.

Function Comparison		
Function	**Organelle**	**Organ System**
converting food into usable energy		
transporting substances		
storing and eliminating wastes		
protecting from the environment		
exchanging gases		
providing support and strength		
acting as central activity control		

Sort the following terms into the appropriate spaces in your table.

- cell membrane
- vacuole
- excretory system
- nervous system
- respiratory system
- cytoplasm
- cell wall
- skeletal system
- integumentary system (skin)
- nucleus
- mitochondrion
- digestive system
- circulatory system

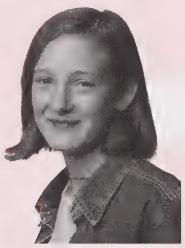
Some terms will appear in several spaces. Look ahead to "Topic 6: Body Systems in Humans" if you need additional information on the organ systems. Topic 6 starts on page 146 of the textbook.

19. On average, how much larger are plant or animal cells than bacterial cells?

20. Why do skin, heart, and lung cells need to reproduce?

Compare your responses with those in the Appendix on page 83.

Going Further



Art in Science? Really?

Do you enjoy both art and science? Do you love creating computer graphics? Then scientific illustration might be the career for you! Check out the "Career Connect" on page 126 of the textbook.

Looking Back

In this lesson you viewed and compared the structures of plant and animal cells by viewing them under a microscope. You looked at both unicellular and multicellular microscopic organisms. You discovered that even with a variety among cells, they have similar structures for similar functions. You became skilled at preparing slides, using a microscope or slide viewer, and recording your observations. And you learned to appreciate why you can think of cells as the basic units of life.

Section Review

Do the following questions to review the concepts covered in this section.

1. Fill in each blank with one of the following terms:

- cell
- cellulose
- cytoplasm
- grow
- microscope
- organelles
- unicellular
- wet mount
- cell membrane
- characteristics
- energy
- life
- multicellular
- respond
- vacuoles
- cell walls
- chloroplasts
- functions
- magnify
- nucleus
- structures
- wastes

a. The basic unit of all life is the _____.

b. All living things require _____, _____ to stimuli in their environment, reproduce and _____, and produce _____ which they must then eliminate. These are some of the _____ of living things.

c. The invention of the _____ made it possible to see and study the _____ and functions of cells and micro-organisms.

d. All cells must carry out the same basic _____.

e. _____ are structures in cells that allow them to carry out all the activities necessary for _____.

f. Plant cells have _____ to provide support and _____ to produce food from light energy.

g. When you _____ objects they appear to be larger.

h. A(n) _____ organism consists of only one cell.

i. _____ organisms consist of many specialized and organized cells.

j. A slide prepared with water and a cover slip is known as a _____ slide.

k. _____ is the constantly moving jelly-like substance responsible for transporting materials within the cell.

l. The non-living, rigid material used to build cell walls is _____.

m. All cells have a _____ that controls cellular activities, _____ to store food and wastes, and a _____ that surrounds and protects the cell contents.

2. Magnification can make small things visible but too much magnification can limit your view.

a. If you were magnified 10X, how tall would you appear to be? If you were magnified 1000X, how tall would you appear to be? If you are not sure of your height, you can use 1.5 m. Express your answers in m and km.

b. If a single-celled organism was 20 µm long and you magnified it 10X, how large would it appear to be? How long would it appear to be if you magnified it 1000X? Express your answers in both µm and mm.

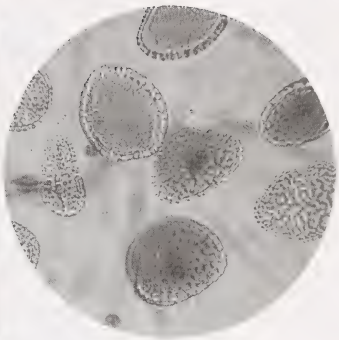
c. As the magnification increases would you see more, less, or the same amount of the specimen in your field of view?

Compare your responses with those in the Appendix on page 84.

3. Do questions 1, 2, and 10 from "Wrap-up: Topics 1 to 3" on page 127 of the textbook.

Compare your responses with those in the Appendix on page 85.

Conclusion



In this section you explored the basic structures of life—visiting cells on the microscopic level. To aid in this visit you briefly checked the history of both science and technology. You then developed a variety of scientific skills including the following:

- observing
- creating tables and diagrams
- wet mount slide production
- microscope use

How does a microscope work? What are the components of a cell? How do plant and animal cells differ? How do unicellular organisms carry out life functions? What prevents most cells from becoming macroscopic? These are only some of the questions your voyage of discovery has taken you past so far.

But what else does the tiny basic unit of life share with you? How can cells build together to create complex living structures of bone, brain, and muscle? In the next section you will continue your scientific journey to discover more about the complexities of life.

Turn to Assignment Booklet 2A. Complete questions 11 to 14 from Section 1.

Section 2

Cells and Their Functions

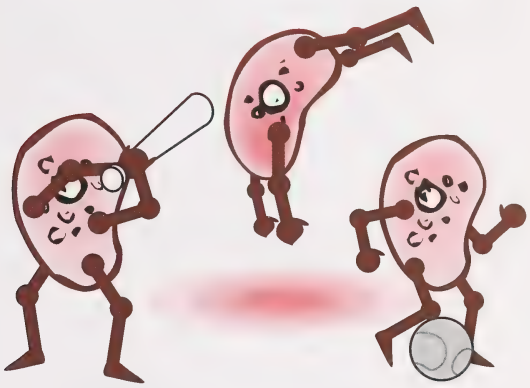
Maybe you went for a long hike with your family or friends on a warm afternoon. You forgot to take water with you. As time passed you became more and more thirsty. This seemed to add to your fatigue.

It was a big relief when you got back to your cooler and water bottle, which you had left in the car. Having a drink of cold water was so refreshing and thirst-quenching.

When you gulped down that water you weren't just satisfying your wants; you were supplying all your cells with moisture. You can think of thirst as the collective cry of "Give me water!" from the billions of cells that make up your body.

All cells need water to carry out their jobs or functions. In this section you will explore cell functions in multicellular organisms to see how cells are specialized and organized so they can team up to get jobs done.

Lesson 1: Fluid Movement in Cells



Cells are involved in countless activities. Like you, individual cells take in food, oxygen, and water. They must also be able to get rid of wastes and protect themselves from harmful substances. The cell membrane plays an important role—it controls what substances can come into and go out of the cell.

Particle Movement

In the next activity you can observe some sweetened drink powder going from the bottom to the top in a glass of water. The change in colour and taste will show that particles can move on their own in water.

Not only will you learn about particle movement, but you will also end up with a refreshing treat.

Find Out Activity Beverage Science

There's a lot to be discovered in a beverage.

Materials

- a tall, narrow drinking glass or jar
- a 15-mL measuring spoon or a tablespoon
- sweetened drink powder, such as iced tea or a fruit-flavoured punch
- water

Procedure

Step 1: Pour a cup of water at room temperature into a narrow beverage glass or jar. Allow the water to settle for 10 minutes.

Step 2: Gently pour two heaping tablespoons of sweetened drink powder into the water. **Do not stir the mixture or move the container**.

Step 3: Use your tablespoon or measuring spoon to carefully dip some water from the surface of the liquid and taste it. Observe the colour of the liquid and the amount of drink powder at the bottom of the tumbler.

Step 4: Repeat Step 3 every half-hour until all of the drink powder disappears from the bottom of the container and no further observable changes take place. **Be very careful not to stir the mixture or move the container**!

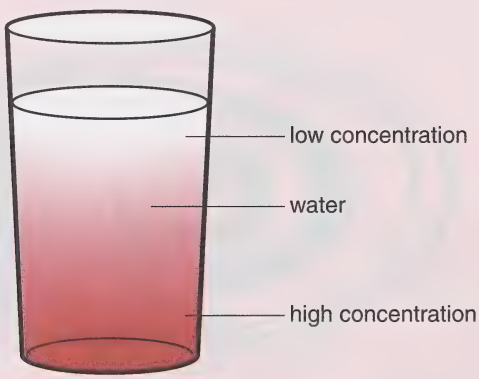
What Did You Find Out?

1. How did the taste and colour of the liquid at the top of the container change over time?

2. Based on your observations, did the sugar, flavour, and colour particles move from lower to higher concentrations or from higher to lower concentrations?

3. Sketch a diagram like the following.

Particle Movement



The particles of the beverage-mix powder move from one place to another in the container. Draw an arrow on the container to indicate the direction of this beverage-particle movement.

Compare your responses with those in the Appendix on page 86.

Diffusion and Osmosis

diffusion: the movement of particles within a fluid from higher to lower concentrations

The movement of particles you observed in "Find Out Activity: Beverage Science" was due to **diffusion**. The drink-mix particles drifted from areas of high concentration to areas of low concentration.

In the activity the drink-mix powder was the solute. It was the solute particles that diffused within the water.

osmosis: the diffusion of a solvent—usually water—through a selectively permeable membrane

membrane: a thin, soft, pliable, porous layer of solid material especially of animal or plant origin

There is a special kind of diffusion called **osmosis**—it's based on the diffusion of water particles. Osmosis requires a special **membrane** to separate the areas of high and low concentration of a solute in water. With such a membrane in place, the water particles move rather than the solute.

In osmosis the solute will not come or move because it is held in place by the membrane. The water has to come over instead.

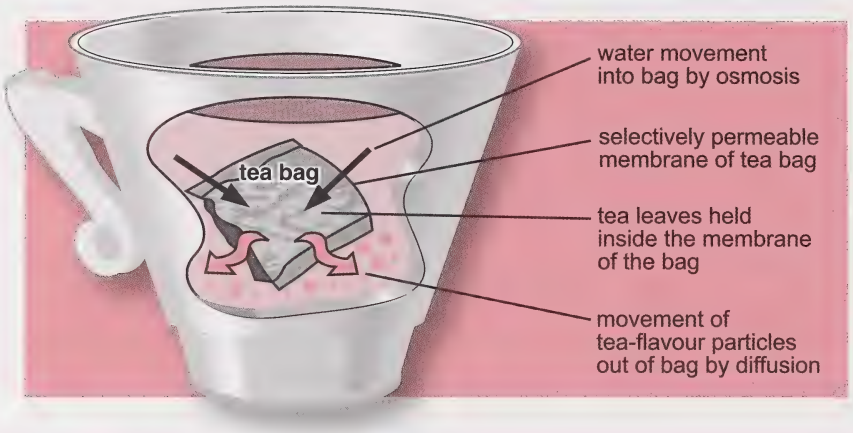
selectively permeable membrane: a membrane that lets particles through on the basis of particle size

You can think of the special membrane as having many little gates in it. The gates are large enough to let water particles through, but too small to let particles of solute through. Such a membrane is a **selectively permeable membrane**.

Think back to when you, or someone in your family, last made a cup of tea from a tea bag. Water moving into the tea bag causes it to swell. You can think of this as osmosis across the tea-bag paper. The paper is a selectively permeable membrane that keeps the tea leaves from going outside the bag but lets water come in freely.

Besides osmosis, there are other things happening as the tea steeps or soaks. Once the tea bag sits in the water for a few seconds, the water dissolves the tea flavour in the tea leaves and the flavour then diffuses throughout the water in the cup. The tea-bag paper is not a barrier for the flavour particles. These particles are too small to be held back—they easily pass through the gates or pores of the tea-bag paper.

Diffusion and Osmosis in a Teacup


water movement into bag by osmosis
selectively permeable membrane of tea bag
tea bag
tea leaves held inside the membrane of the bag
movement of tea-flavour particles out of bag by diffusion

To gain a more complete picture of how particles move by diffusion and osmosis, read pages 128 to 131 of the textbook. Then, in your notebook, answer the following questions.

4. Imagine that you are pouring a mixture of water and marbles into three bags. Classify these bags as permeable, impermeable, or selectively permeable to your mixture. Give reasons for your answers.

a. a plastic bag
b. a cheesecloth bag
c. a bag made of a single-layered basketball net

Compare your responses with those in the Appendix on page 86.

5. On page 8 of the textbook are the five key ideas of the particle model of matter. Which three key ideas of this model best explain diffusion?

6. There are factors limiting the size of cells.

a. Use the information in "Off the Wall" on page 129 of the textbook to explain why the maximum size of a cell is limited.

b. How have large organisms overcome this cell-size limitation?

7. Do questions 1 to 3 from "Topic 4 Review" on page 137 of the textbook.

Compare your responses with those in the Appendix on page 86.

In the next investigation you will use a chicken egg to study osmosis. You will use a chicken egg because there is a selectively permeable membrane just underneath the shell. All you have to do is remove the shell to expose this membrane.

You can easily remove the shell by placing the whole egg in vinegar. The acidic vinegar will react with the calcium-rich shell. In the reaction the shell is dissolved and the membrane is exposed.

Place two uncooked eggs in a container and cover them with vinegar. They need to sit in the vinegar for 24 hours before you do the next investigation.

Investigation 2F Measuring Osmosis

Refer to the "Inquiry Investigation" on pages 132 and 133 of the textbook.

Prepare a salt solution by mixing about three tablespoons of salt with 200 mL of water. Follow the steps of "Procedure." Remember to make written notes for the steps that have a photo of the pencil beside them.

If you don't have distilled water you may use tap water.

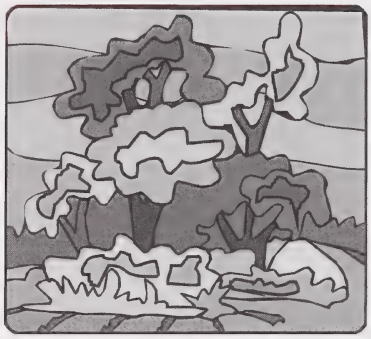
If you don't have access to a triple-beam balance, do your weighing with a spring scale. Use the mass readings indicated in grams. Weigh an egg by placing it in a baggie as shown in the photo. To get the weight of just the egg, subtract the weight of the empty baggie if it registers on the scale.

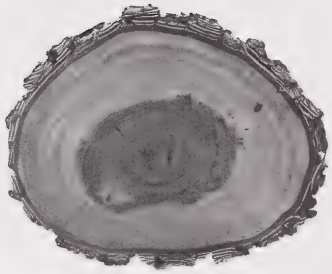
Don't bounce objects off the spring scale or play tug-of-war with it. The scale will break.

8. Complete questions 2 to 4 from "Analyze" and "Conclude and Apply" on page 133.

Compare your responses with those in the Appendix on page 87.

Fluid Movement in Plants





Plants get water from the soil through their roots. The water is needed throughout the plants, especially in the leaves. This means water has to move within the plants. The stem must carry all the water from the roots to the leaves.

For information on fluid movement in plants, read the words and study the diagrams on textbook pages 134 and 135, and read the top of page 137. Also, carefully examine the diagram at the top of page 136. Answer the following related questions.

9. Why do plants need a large supply of water?

10. Write definitions for each of the following plant-structure terms: *vascular tissue*, *phloem tissue*, *xylem tissue*, and *root hairs*.

Can't recall what phloem and xylem do? Just remember this expression: "Phloem food down." That leaves xylem to carry water up.

11. The cells in a tree trunk are arranged in concentric circles in order from the outside to the centre. This is the order:

- bark
- phloem
- cambium
- sapwood

Sort them into two groups of "living cells" and "dead cells."

12. What familiar object does xylem tissue resemble? Why?

13. Why are leaves usually thin and flat?

transpiration: the evaporation of water from leaves via the stomata

14. **Transpiration** is an extremely important part of the environmental "**water cycle**." If plants did not transpire, water would sink deep into the soil. The amount of water in the atmosphere would drop severely, creating an extreme worldwide drought. How is transpiration different from the evaporation of water?

water cycle: the process in which Earth's water moves between the oceans, the land, and the atmosphere

15. Two processes and actions transport water to the tops of plants—even very tall trees. Water gets to the top without a pump like a heart. What two processes and actions are involved in the upward movement of water in plants?

16. Draw a flow diagram of the movement of water to the atmosphere after the water flows from the soil and through a plant.

Compare your responses with those in the Appendix on page 88.

Transpiration puts water into the atmosphere. That is why transpiration is an important part of the water cycle.

Transpiration by a plant is also important to the plant itself. The next activity will show this and outline how leaves are involved in transpiration.

Find Out Activity Transpiration and Leaves

Refer to the activity on page 136 of the textbook.

Follow the steps in "Procedure." Only make cuts with your teacher or home instructor present to guide you.

17. Complete question 1 of "What Did You Find Out?"

18. Do questions 6 and 7 from "Topic 4 Review" on page 137 of the textbook.

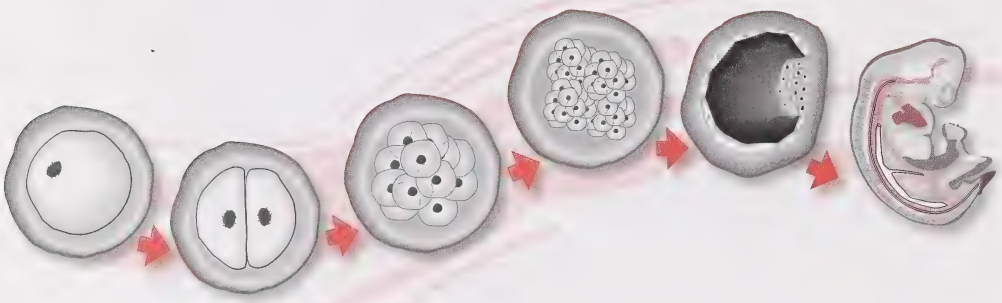
Compare your responses with those in the Appendix on page 89.

Looking Back

In this lesson you identified the needs of cells by relating these needs to your own need to breathe, eat, and drink. Through experimentation, you investigated diffusion and osmosis. You also saw that fluid transport is important for cells.

Turn to Assignment Booklet 2A. Complete questions 1 to 6 from Section 2.

Lesson 2: Cell Specialization and Organization



Every organism begins life as a single cell. For multicellular organisms, such as this pig embryo, things quickly become more complex. The first cell divides. The new cells divide, and so on. Then something else happens early in the division process. Cells begin to **specialize** and organize into **tissues**. Tissues organize into **organs**. These organs link with other body structures into **organ systems**.

specialize: to have a different structure or appearance to perform a particular function

Specializing

Read pages 138 and 139 in the textbook to find out more about cell specialization.

1. List two examples of how a cell's shape relates to its function. Use one plant and one animal example.

2. Match photographs A to E on the top of page 139 of the textbook to the five functions listed in the sentence just above the photographs.

3. What are two disadvantages of being unicellular?

tissue: a group of cells with the same structure and function that work together

organ: a group of tissues that work together to perform a specific function

organ system: an organ and its associated structures that work together to perform a specific function

Compare your responses with those in the Appendix on page 89.

The Levels of Organization

Build on what you know about cell specialization as you organize information at a more complex level by exploring the textbook information on pages 140 and 141, the bottom half of page 142, and the top of page 144.

4. What are three advantages of being multicellular?

Even a microscopic creature shows complexity.

levels of organization: the arrangement of structures from simple to complex

5. **a.** List the four **levels of organization**.
b. What do you think could be the fifth level of organization?
c. What level of organization could be added before the cellular level?

6. Create a data table to store the name and function of three plant tissues and four animal tissues.

7. List four animal organs and three plant organs.

8. Name the three systems found in plants.

Find Out Activity Looking at Animal Tissues

Refer to the activity on page 142 of the textbook. If you don't have a group to work with, work on your own.

9. Follow the steps in "Procedure." Record the results in your notebook.

10. Complete both questions in "What Did You Find Out?"

Compare your responses with those in the Appendix on page 89.

11. Do question 4 from "Topic 5 Review" on page 144 of the textbook.

Compare your responses with those in the Appendix on page 91.

Going Further

What happens if one of my organs quits working?

Research one or more human organs. Use "Think and Link Investigation 2G" on page 143 of the textbook as a guide. You may want to present your project to your family, to your friends, or to a group. Or perhaps you will decide to get them actively involved in the project with you.

Looking Back

In this lesson you identified various types of specialized cells and tissues from both plants and animals. You appreciated that such specialized cells are organized into tissues, while tissues are organized into organs, and organs are grouped into organ systems. This specialization provides advantages for multicellular organisms.

Section Review

Do the following questions to review the concepts covered in this section.

Fill in each blank with one of the following terms:

- diffusion
- organ systems
- phloem
- reproductive
- selectively permeable
- tissues
- water
- impermeable
- organs
- plant food
- root
- shoot
- transpiration
- water and minerals
- levels of organization
- permeable
- related
- root hairs
- specialized
- vascular
- xylem

1. A cell membrane is _____ because it allows only certain substances in and out of cells.

2. Cells are _____ to do certain tasks.

3. The cell structures are_____ to the functions they perform.

4. Cells with the same structure and function are grouped into _____, which form _____, which work together in _____.

5. The arrangement of cells, tissues, organs, and systems represent different _____.

6. The three systems found in plants are the _____ system, the _____ system, and sometimes a _____ system.

7. The two types of _____ tissue that transport materials in plants are _____ and _____.

8. _____ is the loss of water to the environment through a plant's stomata.

9. Phloem tissue transports _____ down from the leaves.

10. Xylem tissue transports _____ up from the roots.

11. The extensions of plant epidermal tissue that absorb water and nutrients from the soil are called _____.

12. Osmosis is the diffusion of _____ across a selectively permeable membrane.

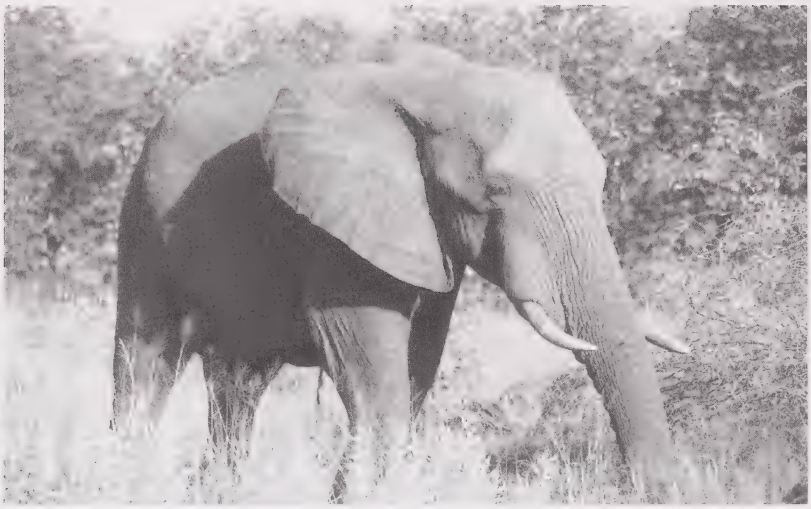
13. A membrane that allows all materials through is said to be _____.

14. If nothing can cross a membrane, it is classified as _____.

15. _____ is the movement of a solute through a solvent from a region of high concentration to a region of low concentration.

Compare your responses with those in the Appendix on page 91.

Conclusion



In this section you investigated the make-up and functions of cells. You saw the importance of osmosis to living things. You also looked at the organization of cells in organisms. This section took you on a journey through the organizational levels of living things.

You compared multicellular living things to single living cells and discovered that diverse living things have much in common. Based on its organization, even a huge elephant has many similarities to living things that you can only see with a microscope.

Turn to Assignment Booklet 2A. Complete questions 7 to 12 from Section 2.

Section 3

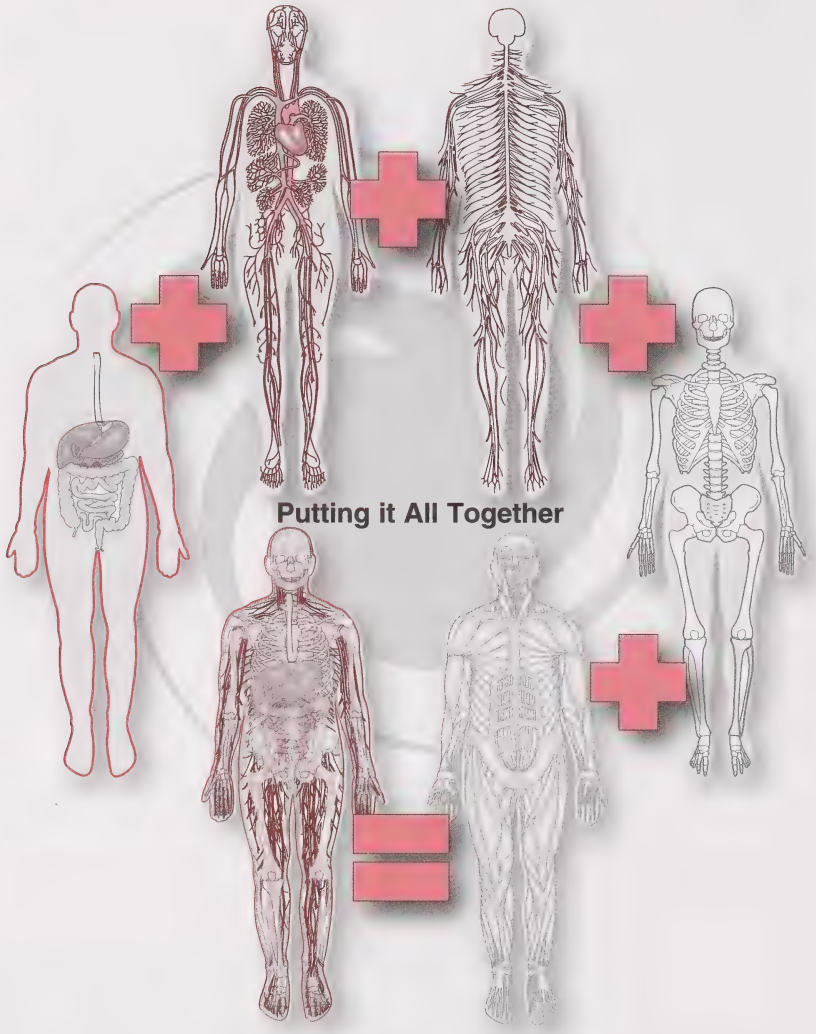
Systems in an Organism

Have you ever used a sponge to wash a car? You may have used a synthetic sponge made of porous rubber or plastic that is modelled after natural sponge. Humans have used natural sponges for hundreds of years—they have been used to pad suits of armour and for bathing. Natural sponge is just the porous skeleton of certain aquatic organisms—sponges—that grow on underwater surfaces. These organisms are multicellular and consist of a mass of living cells that are supported by a porous skeleton.

As an organism, a sponge "drinks" more than 60 glasses of water daily. Imagine doing that! A sponge filters the water by absorbing oxygen and consuming water-borne particles. Yet, sponges are considered to be simple organisms; they have no organs, let alone organ systems. You, on the other hand, are a complex organism. Your body is made up of numerous organs that are organized into many different organ systems.

Your body systems must work together to keep you alive and healthy. In this section you will examine several organ systems and look at how they work together. You will also think about factors that affect these systems and, in the end, your health.

Lesson 1: Body Systems in Humans



digestive system: the system that breaks food down into small, soluble particles and eliminates solid waste

respiratory system: the system that moves air into and out of the body

circulatory system: the system that circulates blood throughout the body

You are now aware that complex living things must be organized at four major levels—cellular, tissue, organ, and organ system. The organ systems must work together to keep the whole organism alive and healthy.

Your **digestive system** is involved with all the meals you eat, while your **respiratory system** is involved with every breath you take. And your **circulatory system** is involved with every one of your heartbeats.

Find out more about these systems by reading the textbook on page 146 and the top of page 147.

1. Match the following body parts with the body system they belong to.

Body Parts	Body Systems
_____ **a.** alveolus	A. circulatory system
_____ **b.** diaphragm	B. digestive system
_____ **c.** gall bladder	C. respiratory system
_____ **d.** pancreas	
_____ **e.** right ventricle	

For a stimulating change of pace, activate some of your body systems by doing the next activity. If you have any health problems that prevent you from exerting yourself, do **not** do the following activity.

Find Out Activity Changing Your Pulse Rate

Refer to the activity on page 147 of the textbook.

2. Complete the steps in "Procedure" and record your results. Rest until your pulse has returned to its original value.

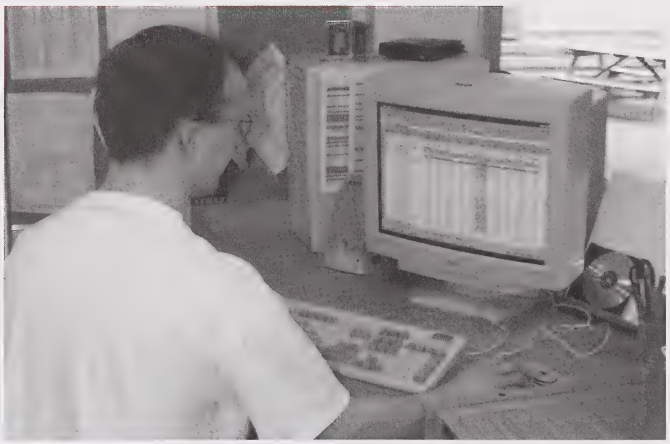
3. Repeat the steps of "Procedure" but this time, instead of doing the knee bends, jump straight up as high as you can.

4. Complete the question from "What Did You Find Out?"

Compare your responses with those in the Appendix on page 92.

Think back to the last activity. Did you notice that your breathing rate went up as your pulse rate increased? This shouldn't be a big surprise. The respiratory and circulatory systems are connected to each other and also to other body systems.

Connecting and Interacting



Maybe one day you left some homework to the last minute. It seems that mistakes happen when you're in a hurry. You logged onto your computer and started your assignment. You were well on your way when you needed to get some information about the area of forested land in Alberta. But your modem wasn't plugged in; until you got that fixed, you couldn't get on the Internet.

You finally got your assignment done and were ready to print it. During several printing attempts you noticed that the printer did nothing. You then remembered that you had lent your printer to a friend. When you got it back, you forgot to connect and plug your printer into the power supply. Once you set up the printer, everything was fine.

Your computer depends on the monitor, printer, modem, and other computer systems working together. When these systems are connected and interact properly with each other, work or functions can be completed. For your body to perform life functions, individual body systems must be connected and interact properly.

Read pages 148 and 149 of the textbook. You will find out how the respiratory, circulatory, and digestive systems are connected and how they work together.

5. Where do the respiratory and circulatory systems connect? Be specific.

alveoli: tiny air sacs in the lungs; the area of gaseous exchange

villi: tiny, finger-like projections on the inner surface of the small intestine

capillaries: tiny, one-cell thick blood vessels; the area of material exchange between the blood and the cells

6. In what ways are the **alveoli** in the lungs similar to the **villi** in the small intestine?

7. The oxygen from the atmosphere cannot directly reach all body cells.

a. Create a flow diagram that shows the pathway of oxygen from the atmosphere to a cell in the villi of the digestive system. Use all the system components, such as nose, alveoli, left atrium, **capillaries**, and villi that are mentioned on pages 146 to 149 of the textbook.

b. Group the components into systems by drawing a different-coloured box around each system's parts.

c. How would the path taken by the oxygen compare to the path of waste carbon dioxide produced by the cells of the villi, and the path of nutrients required by the cells of the lungs?

Compare your responses with those in the Appendix on page 92.

When you dive into water, you must inhale and hold your breath so that you store enough oxygen for the time you are under the water.

If you can stay under for even a couple of minutes, you're doing well—but still not as well as seals.

A seal's diving ability might surprise you. Turn to page 150 of the textbook and read "Off the Wall" to find out how seals manage oxygen and carbon dioxide while underwater.

Did you know that young children who have been submerged in cold water for more than ten minutes have survived without brain damage?

On April 10, 2001, Sean McCarthy, aged 20 months, followed a dog through a gate at his day-care centre just outside of Ottawa. Sean then tumbled down a steep bank into the fast-moving frigid waters of the nearby creek. The boy was not rescued from the water for ten minutes. His body temperature had plunged, he had stopped breathing, and his little heart had stopped beating.

After his rescue, Sean experienced an astonishing recovery. Refer to the following newspaper story that appeared three days after his seemingly fatal accident.

Signs Promising for Boy Pulled from Creek

By: Ron Corbett
The Ottawa Citizen
April 13, 2001

Three days ago, 20-month-old Sean McCarthy arrived at the Children's Hospital of Eastern Ontario "ice cold" with a body temperature of 26 degrees Celsius and no vital signs. For 2 1/2 hours doctors at CHEO could not detect a pulse or a heartbeat in the young boy.

Yesterday, Sean's condition was upgraded from critical to critical but stable. Although still on a respirator, he has begun to breathe on his own, and has opened his eyes.

There is no sign of damage to the boy's heart, liver, or kidneys, and his lungs, which were filled with fluid when he arrived at the hospital, are improving almost by the hour. There has also been no brain swelling, and with 48 hours having passed—the critical period for sustaining brain damage—there is now little likelihood of that happening.

He is well on his way to a full recovery . . . .

[1]

8. Normally, a person cannot tolerate a lack of oxygen for more than four minutes without brain damage. Yet some young children, such as Sean McCarthy, have remained in cold water without breathing for a long time without any brain damage. Try to explain why these children had no brain damage.

Compare your response with the one in the Appendix on page 93.

[1] Ron Corbett, "Signs Promising for Boy Pulled from Creek," *Ottawa Citizen*, 13 April 2001, <http://www.lifesaving.com/spotlight/rescues/spotlight 58.htm> (25 June 2002). Reproduced by permission.

Air is brought in and out of your lungs as you breathe. When you inhale, the diaphragm moves down and the rib cage moves out. This increases the size of the chest cavity. When you exhale, the diaphragm moves up again and the rib cage moves back in. This reduces the size of the chest cavity again. But what makes the lungs inside the chest cavity expand and contract? In the next activity you will make a model to answer this question.

Find Out Activity: Make a Model of the Lungs

Refer to the activity on page 150 of the textbook.

Follow the steps in "Procedure."

9. Answer questions 1 to 3 of "What Did You Find Out?"

Check your answers with your teacher or home instructor.

To stay healthy, your body must be able to eliminate wastes from the blood. Read the paragraph on the excretory system at the top of page 151.

Do you want to know more about the important role of kidneys? Then do the next "Going Further."

Going Further

Turn to page 151 of the textbook and read "Find Out Activity: Employment—Excretion!"

Pretend you are a body that needs a kidney. Use the "Procedure" to make an advertisement aimed at kidneys that are "looking for work." Also, you may want to look at some real job ads in a newspaper for more ideas.

You should end up with a message that is both clear and attention grabbing. It might even be a bit wacky. Have fun and share your ad with others.

Co-ordinating Body Systems

CNN/GETTY IMAGES

AP/WIDE WORLD PHOTO

Maybe you know the Edmonton-born actor Michael J. Fox from two popular TV series, *Family Ties* and *Spin City,* or the movie trilogy *Back to the Future*. You have probably heard of former world heavyweight boxing champion Muhammad Ali. Both of these celebrities have Parkinson's disease. This disease first shows up as slight tremors in the hands and progresses to a severe loss of muscle control. Parkinson's disease is a disorder of the **nervous system** that deteriorates certain brain cells.

nervous system: a network of nerve cells that senses internal and external changes and controls and co-ordinates a vast array of body activities

Maybe you know someone closer to home who has to have insulin injections on a daily basis. Insulin is a hormone produced naturally by the **endocrine system** within the body to control the blood's sugar level. A person with diabetes may have to inject insulin to keep his or her blood sugar level at a tolerable balance.

endocrine system: the group of glands that produces hormonal secretions distributed in the body via the bloodstream

In an indirect way Parkinson's disease, diabetes, and other ailments show the importance of body systems working together. These ailments show what happens when co-ordination is disrupted. The nervous system has an important role in co-ordinating the muscular system. The endocrine system is important in balancing chemicals to keep all the other body systems healthy and responding to changes in the environment.

Turn to pages 151 to 153 of the textbook and read "Sensory Awareness Systems." Include "Across Canada" in your reading.

10. How does your nervous system monitor external temperatures?

Compare your response with the one in the Appendix on page 93.

A simple reflex is a quick and automatic response controlled by a nerve signal that reaches the spinal cord but does not reach all the way to the brain. The knee-jerk reflex is a simple reflex. It is also one of the reflexes that helps the body control the legs during running.

When the doctor checks whether your leg jerks in response to a knee tap, the doctor is getting information about how well your nervous system is working. In the next activity you will check the knee-jerk reaction.

Find Out Activity A Simple Reflex

Refer to the activity on page 152 of the textbook.

Follow the steps of "Procedure" in the textbook if you have a teacher present. Otherwise, ask your home instructor to supervise while you're doing the following steps with a helper.

Step 1: Sit on a sturdy table with your legs hanging freely so that your feet don't touch the floor.

Step 2: Have your helper locate your kneecap and find the tendon at the lower edge of the kneecap. At this position have your helper tap the tendon with the edge of a hand—not a hammer. Note the automatic response of your leg.

Step 3: Switch roles with your helper and repeat the first two steps.

11. Answer the questions of "What Did You Find Out?"

Compare your responses with those in the Appendix on page 93.

12. Do questions 1, 3, and 5 from "Topic 6 Review" on page 153 of the textbook.

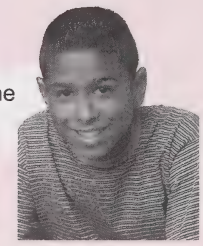
13. Which Canadian researchers discovered insulin?

Compare your responses with those in the Appendix on page 93.

Going Further

Wow! The endocrine system sounds neat.

I'm more interested in the circulatory system.



You may want to do one of the following:

- Perhaps a particular body system—or systems—interests you. Search the Internet, the library, periodicals, and other information sources to compile a list of facts that you can use to astound and amaze your friends and family.

- Put it all together! Get a body-sized piece of paper or cardboard. Have someone trace your body outline on it. Draw life-sized body systems into your outline and/or paste in diagrams you have created on separate pieces of paper. Colour, label, and connect your systems. You will need to locate system diagrams on the Internet or in a book.

Looking Back

In this lesson you expanded your understanding of the major organ systems of your body. You also made the link between activities such as eating, physical exertion, and breathing to events within the body. You identified these events at the system level and down to the cellular level of organization. You also described how the connection and interaction among systems is needed for your well-being.

Turn to Assignment Booklet 2B. Complete questions 1 to 4 from Section 3.

Lesson 2: Body Systems and Your Health

You started this module by considering the characteristics that all living things share. These are characteristics that make organisms distinctly different from non-living things.

You then went down through the levels of organization of organisms into the microscopic world of the cell—the basic unit of all life. After gaining skills with the technology involved in the study of cells and their organelles, you worked your way up again through the levels of organization.

You now need to consider the importance of keeping a special organism—yourself—healthy and fit. Food, exercise, sleep, and your environment are lifestyle factors that affect each cell and system in your body, and therefore contribute to your overall health and well-being. You may feel invincible at this point in your life. However, your current lifestyle choices will have a long-term effect on your health.

Scientific research and new technologies have led to significant advances in the understanding of cells, body systems, disease, lifestyle factors, and medical treatments. This knowledge allows you to make wise lifestyle choices that will promote long-term health.

Health and Your Circulatory System

Do you enjoy physical activities such as soccer or volleyball? How about mountain biking? Such activities can be strenuous and your heart may pump blood through your arteries and veins at twice the rate as when you're sleeping. For this rapid pumping you need a healthy heart and a healthy circulatory system. The circulatory system connects all the other body systems by transporting heat, oxygen, antibodies, nutrients, hormones, and wastes. What are the indicators of a healthy circulatory system? What diseases and lifestyle factors can affect it? What choices can you make to keep it healthy?

Find out the answers to these questions by reading pages 154 to 157 in the textbook.

1. Why do humans need a circulatory system while amoebas don't?

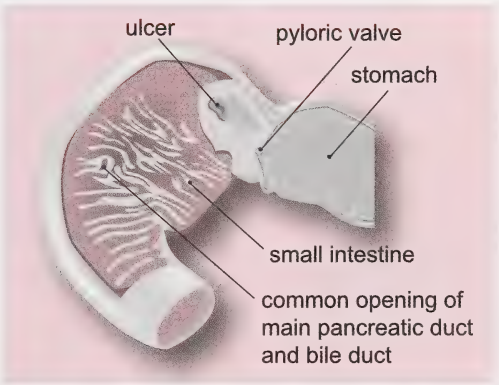
2. List five factors that increase the risk of developing disorders of the circulatory system.

Compare your responses with those in the Appendix on page 94.

Going Further

When Alice in Wonderland drank from a bottle, she grew smaller and then larger. Imagine taking on the sizes of various organisms; creatures would look very odd if they were as large as you. You might wonder if an organism that appeared to be as big as you had a circulatory system just like your own. Use the Internet, the local library, and other information sources to check out the circulatory systems of other organisms, such as sponges, insects, earthworms, fish, frogs, and birds. You may be surprised and intrigued by what you find!

Health and Your Digestive System



For many years it was believed that it was just stress that caused stomach ulcers. Now medical researchers have discovered the cause of peptic ulcers—bacteria called H. pylori. The bacteria can cause the breakdown of the mucous layer that protects the stomach wall. Digestive acid and enzymes then corrode the stomach lining and create a painful sore.

For those who do suffer from ulcers the cure is now simple—they take antibiotics to kill the bacteria.

The health of your digestive system is important: every one of your cells requires energy and nutrients to survive. Food must be processed into soluble particles before your cells can use the food. These particles must diffuse into the bloodstream and be transported throughout the body. The processing and the diffusing are functions of the digestive system.

Read pages 158 and 159 of the textbook to discover more about the digestive system and what can go wrong with it.

3. Answer question 3 of the "Topic 7 Review" on page 162 of the textbook.

Compare your responses with those in the Appendix on page 94.

Are you interested in more information about what you should eat to stay healthy? Then the next "Going Further" is for you.

Going Further

Go to **http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/food_guide_rainbow_e.html**

There you will find "Canada's Food Guide to Healthy Eating." Identify the four main food groups that make up a healthy diet.

You may want to keep a complete record of the food you eat over two or three days to see how closely you follow the guide.

4. Why is a low-fibre diet harmful to your health? Give two reasons.

5. Answer question 5 of the "Topic 7 Review" on page 162 of the textbook.

Compare your responses with those in the Appendix on page 94.

Going Further

Don't think you've seen it all. While the basic body systems have a lot in common, a little exploration shows they also have a lot of very interesting differences. Continue to feed your curiosity by using the Internet, the local library, and other information sources to check out the digestive systems of other organisms, such as sponges, insects, earthworms, fish, frogs, and birds.

Health and Your Respiratory System

Do you remember having a common cold? You likely had a headache and a sore throat and felt tired and chilly. Having to sneeze a lot may have added to your misery. But the worst parts of the cold may have been the constant need for facial tissues and the inflammation of the mucous membrane that made breathing difficult.

The condition of your respiratory system is important to your health: it supplies every one of your cells with oxygen and removes carbon dioxide waste.

Think about your own breathing. You may do it effortlessly. For people living with cystic fibrosis, breathing does not always come easily.

Cystic fibrosis is an inherited disease in which the mucous in the respiratory system becomes extremely thick and sticky. Normally, the mucous is thin and runny so that it carries away harmful dust, viruses, and bacteria. The thick mucous of those people with cystic fibrosis clogs the airways rather than keeping them clean. Without proper treatment, respiratory infections are frequent and breathing is difficult.

Therapy with an aerosol machine helps to thin and drain mucous collected in the lungs. Pounding on the chest and back can dislodge the thick mucous remaining in the lungs. Fortunately, with proper treatment, people with cystic fibrosis can lead active lifestyles.

Turn to page 160 of the textbook. Read more about your respiratory system and what factors can threaten this system.

6. The quality of the air you breathe affects your lungs.

a. What structure do the cells lining your lungs have that traps and removes the dirt and bacteria you breathe in?

b. How do cigarette smoking and pollutants affect the lining of the lungs?

c. Name two conditions that long-term exposure to cigarette smoke and pollutants can cause.

Compare your responses with those in the Appendix on page 94.

statistics: the science of collecting and analyzing numerical information

Complete the next investigation about **statistics** to check the dangers of cigarette smoking.

Investigation 2H Working with Statistics

Refer to the "Think and Link Investigation" on page 161 of the textbook.

Read "Think About It."

7. Complete the first two steps of "What to Do." Place the bar graph in your notebook.

8. Complete questions 1 and 2 of "Analyze."

Check your answers with your teacher or home instructor.

Going Further

If you've been "Going Further," you discovered a wide diversity among organ systems. Are you curious to know if respiratory systems show a similar diversity? Use the Internet, the local library, and other information sources to check out the respiratory systems of other organisms, such as sponges, insects, earthworms, fish, frogs, and birds.

Your Health: Your Choice

Do you have good or bad lifestyle habits? With knowledge comes choice! How do the components of your body work? What factors affect their health? What causes disease? What can you do to promote your own good health? It pays to be informed.

Read "You and Your Body" on page 162 of the textbook.

9. Sort the following items into the categories of "unhealthy" and "healthy:"

- ignoring health problems
- excessive stress
- washing your hands regularly
- being physically active
- smoking
- eating only extremely low-fat food
- getting plenty of sleep

10. What are the essential needs for maintaining healthy organs and systems?

Compare your responses with those in the Appendix on page 95.

Going Further

The following are some ideas if you want to research health topics:

- Use the Internet, the local library, and other information sources to research medical technologies such as PET, CAT, and MRI scans; X-rays; ECG/EKG; EEG; blood, urine, hearing, and stress tests; xeroradiography; radioactive dyes and pastes.
- Use the Internet, the local library, and other information sources to research organ transplants and other forms of transplants and implants.
- Use the Internet, the local library, and other information sources to research the effects of smoking on your digestive, respiratory, and circulatory systems.

Looking Back

In this lesson you used scientific understanding to analyze the effects of lifestyle choices on your body systems and, ultimately, your health. You related disorders of the respiratory, digestive, and circulatory systems to choices involving smoking, exercise, and diet. You came to appreciate the benefits of healthy lifestyles, and you collected, analyzed, and interpreted data.

Section Review

Do the following questions to review the concepts covered in this section.

1. Fill in each blank with one of the following terms:

- alveoli
- capillaries
- carbon dioxide
- circulatory system
- digestive system
- endocrine system
- excretory system
- heart attacks
- heart rate
- high
- hypertension
- lifestyle
- low
- nervous system
- plasma
- respiratory system
- sense
- strokes
- villi

a. The _____ breaks food down, both mechanically and chemically, into smaller particles that can be absorbed by the blood in the _____ of the small intestine.

b. The _____ supplies the body with oxygen and eliminates waste _____.

c. The _____ transports food, oxygen, hormones, and wastes throughout the body.

d. The _____ eliminates many of the body's waste materials.

e. Co-ordinating and controlling the body's responses to its internal and external environment is the responsibility of the _____ and the _____.

f. Both the _____ and the villi provide a large surface area for material exchange with the blood.

g. _____, the smallest blood vessels, are made of epithelial tissue that's just one cell thick.

h. The nervous system allows us to _____ changes in the environment.

i. Four components of blood are _____, red blood cells, white blood cells, and platelets.

j. Another name for high blood pressure is _____.

k. Damage to the heart muscle is caused by _____.

l. Brain damage may be caused by _____.

m. Blood volume, _____, artery size, artery elasticity, and blood viscosity can be used to indicate the health of your circulatory system.

n. To be healthy, people require sufficient sleep, regular exercise, clean air and water, and a nutritious _____ -fibre, low-fat, _____ -salt diet.

o. Your _____ choices today will affect your health and well-being in your future.

2. Do questions 2, 4, 5, and 8 in the "Wrap-up: Topics 6 to 7" on page 163 of the textbook.

Compare your responses with those in the Appendix on page 95.

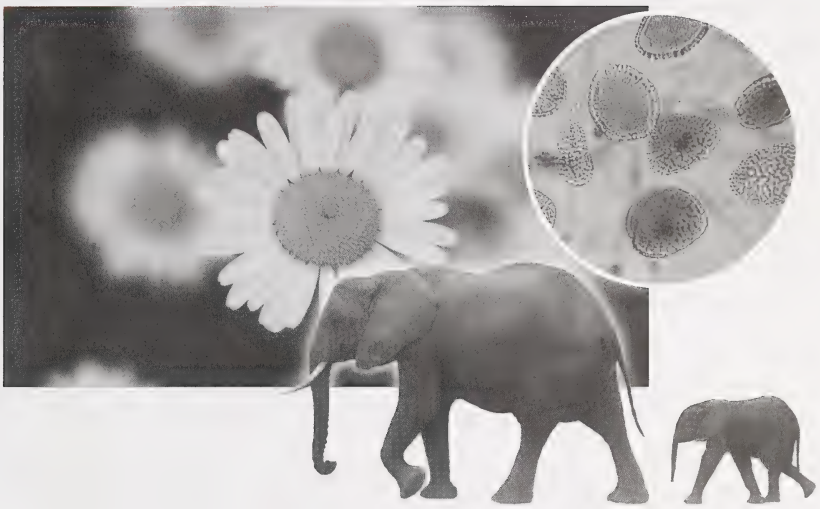
Conclusion

This section dealt with organ systems—the highest level of organization in living things. You focused on the human body to appreciate the interdependent roles systems play in keeping the body alive and well.

Many people enjoy participating in sports. To be part of a successful team you must be healthy, and that depends on keeping your organ systems healthy. You know that lifestyle choices have an influence on the health of your organ systems. If you choose a positive lifestyle, you will likely have much to cheer about.

Turn to Assignment Booklet 2B. Complete questions 5 to 13 from Section 3.

Module Summary



In this module you travelled from the microscopic world of unicellular organisms to the higher organizational levels of multicellular organisms. The journey took you all the way up to the complexity of organ systems. During this time you made important observations with scientific instruments about patterns in diversity. Along the way you gained an understanding of how cells, tissues, organs, and organ systems work together in living things.

You started out this module with a question about the similarities between a bacterium, a plant, and an elephant. You have taken a journey from the microscopic world of bacteria to the everyday world of flowers and large mammals. The trip gave you a better understanding of the similarities among living things and a better sense of their differences.

Module Review

Do the following questions to review the concepts covered in this module.

1. A science investigation starts out with a question. The question must be designed in a special way for it to lead to an effective investigation plan. The question should be something like this:

> How does the manipulated variable (MV) affect the responding variable (RV)?

Write one or more questions for an investigation related to the following.

a. You want to research the effects of different food sources on your microscopic organism's ability to live and reproduce.

b. You are curious about why diffusion across the cell membrane and through the cytoplasm limits the maximum size that cells can grow to.

2. Match the following to show the functions of microscope components.

_____ **a.** coarse-adjustment knob	A. controls the amount of light reaching the specimen
_____ **b.** diaphragm	B. used for adjusting the focus of the low-power objective lens
_____ **c.** stage	C. supports the microscope slide
	D. used for adjusting the focus of the high-power objective lens

3. List and give the function of four organs found in your body.

4. List five things you can do to promote the health of your organs.

5. You can sometimes communicate scientific concepts more effectively by using graphics. Create an events chain map or a flowchart to show the stages of the simple reflex that occurs when your finger touches a hot frying pan.

6. Cellular respiration is a process that takes place in a cell's mitochondria. During respiration, sugar reacts with oxygen to produce carbon dioxide, water, and energy. You know that plants carry on photosynthesis to produce their own food. Photosynthesis is a process that uses up carbon dioxide, water, and energy.

   Do you think that plant cells carry on respiration as well? Explain your answer.

7. Compare diffusion with osmosis.

8. What three important characteristics do villi and alveoli share?

9. Name three of your body systems that are harmed by smoking. Describe a negative effect of smoking for each system.

10. List six characteristics that all living things share.

11. Match the following.

_____ **a.** arteries	A. where substances move between the blood and cells of the body
_____ **b.** capillaries	B. carry blood to the heart
_____ **c.** veins	C. carry blood away from the heart

12. How does an organelle compare to an organ?

Compare your responses with those in the Appendix on page 96.

Turn to Assignment Booklet 2B and do the Final Module Assignment.

SCIENCE 8

APPENDIX

Glossary

Suggested Answers

Image Credits

Glossary

alive: having all the characteristics of living things

alveoli: tiny air sacs in the lungs; the area of gaseous exchange

capillaries: tiny, one-cell thick blood vessels; the area of material exchange between the blood and the cells

cell: the smallest unit that can perform all the functions of life

cell membrane: the thin, selectively permeable structure that encloses a cell or organelle

cell wall: a rigid, cellulose structure located outside the cell membrane in most plants and fungi; supports and protects the cell

cellulose: a tough, insoluble carbohydrate produced by plant and fungi cells that make up a large part of the cell walls

chloroplasts: organelles containing chlorophyl that enable plants and algae to produce carbohydrates through the process of photosynthesis

circulatory system: the system that circulates blood throughout the body

It includes the heart, blood, and blood vessels.

cytoplasm: a gel-like substance in the cell which contains and supports the organelles

dead: once alive; retains cells and the special make-up of living things

diffusion: the movement of particles within a fluid from higher to lower concentrations

digestive system: the system that breaks food down into small, soluble particles and eliminates solid waste

It includes the stomach and intestines.

dormant: alive but not active or growing

Seeds, eggs, and bulbs may stay dormant in harsh conditions.

endocrine system: the group of glands that produces hormonal secretions distributed in the body via the bloodstream

function: a job, an activity, or a role

impermeable: allowing nothing through

integumentary system: the part of an organism that protects it from the external environment

Skin is part of the human integumentary system.

levels of organization: the arrangement of structures from simple to complex

magnification: the amount an object has been enlarged

magnifying: making an object appear larger

membrane: a thin, soft, pliable, porous layer of solid material especially of animal or plant origin

microscope: an instrument used to magnify structures not visible to the naked eye

multicellular: composed of more than one cell

nervous system: a network of nerve cells that senses internal and external changes and controls and co-ordinates a vast array of body activities

nucleus: the organelle containing genetic material that controls cellular activities

organ: a group of tissues that work together to perform a specific function

organ system: an organ and its associated structures that work together to perform a specific function

organelles: structures in the cell that perform a specific function

These are similar to an organ in a complex organism.

organisms: living things

osmosis: the diffusion of a solvent—usually water—through a selectively permeable membrane

permeable: allowing materials through

phloem tissue: vascular plant tissue that transports food—sugars and starches—throughout the plant

respiratory system: the system that moves air into and out of the body

It includes the lungs, trachea, and nasal passages.

root hairs: tubular projections from root epidermis cells

Root hairs vastly increase the absorptive surface area of the root.

selectively permeable membrane: a membrane that lets particles through on the basis of particle size

specialize: to have a different structure or appearance to perform a particular function

statistics: the science of collecting and analyzing numerical information

structure: anything made of parts arranged together

tissue: a group of cells with the same structure and function that work together

transpiration: the evaporation of water from leaves via the stomata

unicellular: composed of one cell

vacuole: a fluid-filled organelle for the storage of wastes, food, or other materials

vascular tissue: tissue made of tubes that transport fluid

villi: tiny, finger-like projections on the inner surface of the small intestine

water cycle: the process in which Earth's water moves between the oceans, the land, and the atmosphere

wet mount: a slide prepared using water and a cover slip

xylem tissue: vascular plant tissue that transports water and minerals absorbed by the roots throughout the plant

Suggested Answers

Section 1: Lesson 1

1. Only the following are living things:

- spiders
- daisies
- brain cells
- mushroom spores
- bacteria
- mushrooms
- apple seeds

Note: While the classification of some objects are obvious, some are definitely more difficult.

Petrified wood is no longer wood—all the organic or living particles have been replaced by rock particles.

Cake is made from flour, which is just powdered wheat seeds. However, the dormant seeds were processed to create flour. Then the flour was processed to create the cake. The processing changed the structure so much that the cake must be classified as non-living.

Nail clippings are made from a protein called keratin, which is produced by the cells at the base of the nails. Keratin does not have a cellular structure. Therefore, nail clippings are classified as non-living.

You used your own understanding to identify the living things. In the next part of the lesson, you will learn what characteristics living things have in common.

2. Living organisms

- need energy
- respond and adapt to their environment
- reproduce
- grow
- produce wastes

Note: Remember that the bodies of living things are made of cells. You probably also realize that all living things eventually die.

3. a. Answers will vary. A wide variety of structures are used to obtain food in numerous ways. Examples include mouths, teeth, claws, and beaks.

b. The chloroplast is a plant structure used to make food. Chloroplasts are found in leaves.

4. **a.** Answers will vary. Examples include eyes, ears, noses, tongues, and skin. **Note:** There are also a variety of more specific adaptations, such as eyespots, lateral lines, and vibration receptors.

   b. The following are two ways plants can move:

   - Plants can respond gradually by making one side of the plant grow faster than the other side. That is how plants bend toward light.
   - Some plants can redistribute water within their cells to create quick movement. That's how a Venus fly trap catches its prey.

5. Reproduction is the function most closely related to the items.

6. **a.** Animals produce feces, urine, and carbon dioxide.

   b. Plants produce gaseous wastes.

   Note: Like animals, plants produce waste carbon dioxide as they convert their food into energy. Plants also produce waste oxygen as they create their own food during photosynthesis.

Section 1: Lesson 2

2. **Textbook questions 3 and 4 from "Topic 2 Review," page 114:**

   3. **(a)** Anton van Leeuwenhoek first observed single-celled organisms. **Note:** Anton van Leeuwenhoek, a Dutch linen merchant, became interested in building devices to magnify the textiles he bought and sold for a living. His microscopes allowed him to closely check the quality of the materials. Curiosity led van Leeuwenhoek to the discovery of micro-organisms. He built 250 microscopes during his lifetime to see more and more deeply into the tiny world he had discovered.

      (b) He called the single-celled organisms *animalcules*.

   4. English scientist Robert Hooke was the first scientist to use the term *cell*.

3. **a.** They found cells.

   b. All the functions carried out by living things are carried out by their individual cells as well.

14. **Textbook question from "Math Connect," page 111:**

    The field of view has a diameter of 2500 µm. Therefore, the cells would both have diameters of half the field of view diameter, which is 1250 µm.

Section 1: Lesson 3

5. Textbook questions 1 and 3 from "Topic 3 Review," page 126:

1. **(a)** Examples of unicellular organisms include paramecia, amoebas, stentors, volvox, and diatoms.

(b) Examples of multicellular organisms include insects, grass, moss, worms, jellyfish, cats, trees, and clams. Most familiar plants and animals are multicellular.

3. Answers will vary. Observations of the characteristics of life may be as follows:

- an amoeba "swallowing" its prey
- a false foot for moving and capturing prey
- cilia for movement

Note: The amoeba in the process of "swallowing" is direct evidence of life. The false foot is indirect evidence of life, and so are the cilia.

6. **a.** Organelles are structures in the cell that perform a specific function. An organelle is similar to an organ in a complex organism.

b. A cell membrane is the thin, selectively permeable structure that encloses a cell.

c. Cytoplasm is a gel-like substance in the cell which contains and supports the organelles.

d. A nucleus is the organelle containing genetic material that controls cellular activities.

e. A vacuole is a fluid-filled organelle for the storage of wastes, food, or other materials.

f. A cell wall is a rigid, cellulose structure located outside the cell membrane in most plants and fungi. It supports and protects the cell.

g. Cellulose is a tough, insoluble carbohydrate produced by plant and fungi cells that make up a large part of the cell walls.

h. Chloroplasts are organelles containing chlorophyl that allow plants and algae to produce carbohydrates through the process of photosynthesis.

7. Energy is produced by organelles called mitochondria.

8. You are looking at the cell wall.

9. The leaves, the growing tips of branches and roots, a thin layer of cells just under the bark, and the pith in the centre of the roots and branches are parts of a tree that are alive.

12. **Textbook questions 1 to 4 from "Analyze" and "Conclude and Apply," page 120:**

    1. **(a)** High-power magnification shows more internal structures of the cells with greater clarity than does low-power magnification.

       (b) Too much light "washes out" the details of the specimen. With too little light, details disappear because not enough light gets through the specimen.

       (c) Stains stick to the structures in the cells. This makes the structures more visible.

    2. Answers will vary. Some examples are given in the following data table.

Cell Comparisons	
Onion Skin Cell	**Human Skin Cell**
cell wall	**no cell wall**
cell membrane	**cell membrane**
organelles (vacuoles, nucleus) visible	**organelles (vacuoles, nucleus) visible**
vacuoles generally larger	**vacuoles generally smaller**
more vacuoles	**fewer vacuoles**
cells—straight sides	**cells—irregular sides**
cells generally larger	**cells generally smaller**
filled with cytoplasm	**filled with cytoplasm**
no chloroplasts	**no chloroplasts**

3. Cells in the onion skin have rigid cell walls, which give the cells a definite structure. The cells fit together tightly—almost like tiles. This arrangement of the cells forms a strong protective wall.

4. Answers will vary. One possibility is that animals have to move around in search of food. Their bodies need to be flexible to allow movement.

   Plants produce their own food and can therefore remain in one place. However, their bodies must be strong enough to resist forces like wind.

15. Textbook questions 2 to 4 from "Analyze" and "Conclude and Apply," page 120:

2. Answers will vary. Some examples are given in the previous data table titled "Cell Comparisons" on page 82.

3. Cells in the onion skin have rigid cell walls, which give the cells a definite structure. The cells fit together tightly—almost like tiles. This arrangement of the cells forms a strong protective wall.

4. Answers will vary. One possibility is that animals have to move around in search of food. Their bodies need to be flexible to allow movement.

   Plants produce their own food and can therefore remain in one place. However, their bodies must be strong enough to resist forces like wind.

16. Textbook questions 4 to 6 and question 8 from "Topic 3 Review," page 126:

4. With few exceptions, cells have both a cell membrane and a nucleus. **Note:** Most cells have vacuoles. Red blood cells are one of the exceptions. They have become very specialized for carrying oxygen. Red blood cells have a nucleus when they are first formed in the bone marrow. However, as the cells mature their nuclei and mitochondria are forced out, the other organelles dissolve, and the cells fill with hemoglobin. Hemoglobin is the molecule that carries oxygen. Without a nucleus the red blood cells cannot reproduce or repair themselves. As red blood cells die, they are replaced by new red blood cells from the marrow.

5. Scientists stain cells to improve contrast. This makes structures easier to see.

6. Chloroplasts and cell walls are found in a plant cell but not in an animal cell.

8. The root cells of plants do not photosynthesize because they are underground. Therefore, they don't need chloroplasts. Root cells are specialized for absorbing water and nutrients from the soil.

17. Textbook question 7 from "Topic 3 Review," page 126:

7. Organisms grow larger by adding more cells. This is because individual cells cannot carry out life functions when they become very large.

18. Answers will vary. Some terms will appear in several spaces. Many organelles and organ systems carry out several functions in addition to their main function.

Function Comparison		
Function	**Organelle**	**Organ System**
converting food into usable energy	**vacuole, mitochondrion**	**digestive system**
transporting substances	**cell membrane, cytoplasm, vacuole**	**excretory system, digestive system, circulatory system**
storing and eliminating wastes	**vacuole**	**excretory system, digestive system, integumentary system, circulatory system, respiratory system**
protection from the environment	**cell membrane, cell wall**	**skeletal system, nervous system, integumentary system, circulatory system**
gaseous exchange	**cell membrane**	**circulatory system, respiratory system**
support and strength	**cytoplasm, cell wall**	**skeletal system**
central activity control	**nucleus**	**nervous system**

19. Plant or animal cells are, on average, 10X larger than bacterial cells.

20. As skin, heart, and lung cells wear out, and as they become damaged, diseased, or die, they need to be replaced by more of the same type of cells.

Section 1: Review

1. **a.** cell
b. energy; respond; grow; wastes; characteristics
c. microscope; structures
d. functions
e. Organelles; life
f. cell walls; chloroplasts
g. magnify
h. unicellular
i. Multicellular
j. wet mount
k. Cytoplasm
l. cellulose
m. nucleus; vacuoles; cell membrane

2. a. If you were 1.5 m tall:
10×1.5 m = 15 m or 0.015 km

If you were magnified 1000 times:
1000×1.5 m = 1500 m or 1.5 km.

b. If you magnified a 20 μm micro-organism by 10:

$$10 \times 20\ \mu m = 200\ \mu m \times \frac{1\ mm}{1000\ \mu m} = 0.2\ mm$$

If you magnified a 20 μm micro-organism by 1000:

$$1000 \times 20\ \mu m = 20\,000\ \mu m \times \frac{1\ mm}{1000\ \mu m} = 20\ mm$$

c. You would see less of the organism as the magnification increased.

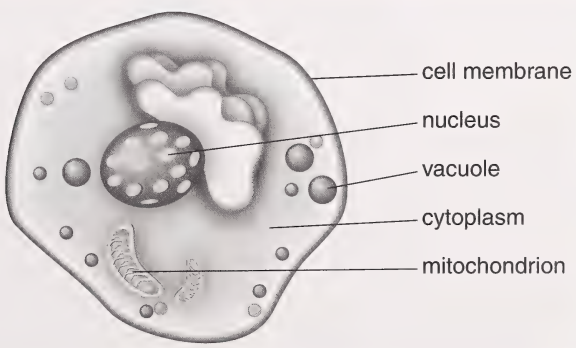
3. Textbook questions 1, 2, and 10 from "Wrap-up: Topics 1 to 3," page 127:

1. The descriptions in column A match the terms directly to the right of them in column B.

A	B
• carries out photosynthesis in plant cells	• chloroplast
• gives plant cells strength and support	• cell wall
• a moving fluid that distributes materials	• cytoplasm
• controls the cell's activities	• nucleus
• a thin, protective "skin"	• cell membrane
• stores materials	• vacuole

2. The earthworm is multicellular. Its body parts are made up of interdependent groups of many types of specialized cells that carry out specific functions.

10. Refer to the diagram on page 122 of the textbook. You should have been able to identify the cell membrane, cytoplasm, nucleus, and vacuoles. You may have also identified the oval-shaped mitochondrion.



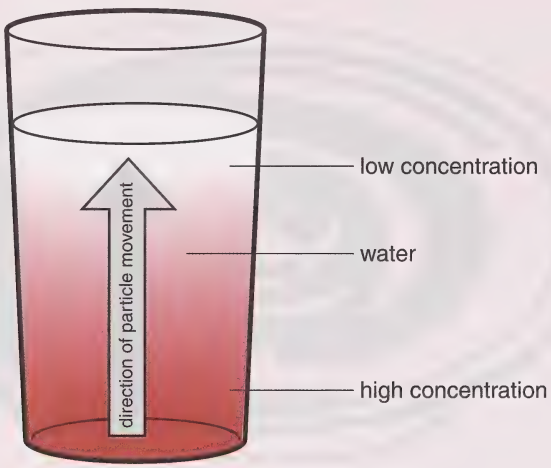
Section 2: Lesson 1

1. The colour and taste both became more intense over time.

2. All particles moved from an area of higher concentration, with lots of particles, to an area of lower concentration, with no or fewer particles.

3. Your diagram should be similar to the following one.

Particle Movement



The process taking place in the beverage container is called diffusion.

4. **a.** The plastic bag would be impermeable to the mixture.

   b. The cheesecloth bag would be selectively permeable because it would let the water through but prevent the movement of the marbles.

   c. The basketball net bag would be permeable to the water and marble mixture because the entire mixture would pass through the bag.

5. The following are the three key ideas that explain diffusion:

   - All substances are made of tiny particles.
   - The particles have spaces between them.
   - The particles are always in motion—vibrating, rotating, and, in liquids and gases, moving from place to place.

6. **a.** If a cell is too large, it would take too long for materials to move from outside the cell into the centre of the cell.

   b. Large organisms are made up of many cells, rather than just one cell.

7. **Textbook questions 1 to 3 from "Topic 4 Review," page 137:**

   1. Osmosis causes water to enter or leave a cell.

   2. Both osmosis and diffusion result in a substance moving. The movement is from an area of higher concentration to an area of lower concentration.

   Diffusion can refer to the movement of almost any substance, while osmosis refers only to the movement of water.

   Osmosis involves a selectively permeable membrane—diffusion may not involve a membrane at all.

   3. The ammonia particles have diffused through the air from the area of higher concentration to the area of lower concentration.

8. **Textbook questions 2 to 4 from "Analyze" and "Conclude and Apply," page 133:**

   2. The variables held constant are the

   - type of egg
   - volume of liquid used
   - amount of time the eggs soaked in the liquid

   The variable purposely changed is the concentration of the salt in the liquids.

   3. **(a)** If the mass of the egg increased, the volume of liquid in the jar decreased.

   (b) If the mass of the egg decreased, the volume of liquid in the jar increased.

(c) In plain water the mass of the eggs increased. The increase in mass was due to the movement of water into the egg by osmosis. With water moving into the egg, less water would remain outside the egg.

In salt water the mass of the egg decreased. This decrease was due to the movement of water out of the egg by osmosis. With water moving out of the egg, the volume of salt water outside the egg would increase.

4. For the egg placed in plain water, the water concentration inside the egg is less than it is in the plain water. The movement of water across the selectively permeable membrane will be toward the region of lower water concentration inside the egg.

For the egg placed in a salt solution, the water concentration of the salt solution outside the egg is lower than the water concentration inside the egg. The movement of water across the selectively permeable membrane will be toward the region of lower water concentration outside the egg. Water will leave the region of higher water concentration inside the egg.

9. Plants need a lot of water to make food through the process of photosynthesis.

10. Note the following definitions:

- Vascular tissue is tissue made of tubes that transport fluid.
- Phloem tissue is vascular plant tissue that transports food—sugars and starches—throughout the plant.
- Xylem tissue is vascular plant tissue that transports water and minerals absorbed by the roots throughout the plant.
- Root hairs are tubular projections from root epidermis cells.

11. Phloem, cambium, and sapwood are living cells, while bark is composed of dead cells.
Note: Cambium is a very thin tissue that produces xylem and phloem. Sapwood is the pale wood just under the bark. It is the xylem of a tree. At the centre of a tree is heartwood, which is composed of dead cells. Heartwood is usually darker and more durable than the surrounding sapwood.

12. It resembles a straw because the tube-shaped cells have thick walls with holes in their ends. They are stacked end to end and form bundles of hollow tubes.

13. They are usually thin and flat to increase the surface area for the absorption of light energy and the diffusion of gases into and out of the leaf. This allows photosynthesis to occur.

14. Transpiration is a special type of evaporation. Transpiration is the evaporation of water from leaves via the stomata.

15. Osmosis pushes water upward, while transpiration pulls water upward—the water particles are held together by bonds of attraction that make the plant's water network behave as a single unit, like a long string.

16. The flow diagram should include the following information.
soil → root hairs → xylem → leaf cells → stoma → atmosphere

17. **Textbook question 1 from "What Did We Find Out?" page 136:**

    1. The coloured water rises farthest in the stalk with leaves. The presence of leaves increases the rate of transpiration. Another answer is that the presence of leaves makes transpiration possible. **Note:** In the stalk without leaves, there is no transpiration—there is only evaporation.

18. **Textbook questions 6 and 7 from "Topic 4 Review," page 137:**

    6. Guard cells open and close the stomata to control the movement of water out of the leaves and the movement of carbon dioxide and oxygen into the leaves.

    7. Spraying fresh vegetables with water keeps the vegetables crisp by decreasing evaporation from their cells and by replacing any water they lose.

Section 2: Lesson 2

1. Nerve cells are long and branched to receive messages in one part of the body and carry them to another.

   Red blood cells are thin and disc-shaped to provide a large surface area for carrying oxygen.

   A plant's water conducting cells are tube-shaped, thick-walled, and fairly open-ended to aid liquid movement.

   Onion skin cells are flat and brick-shaped. They fit closely together to form a continuous protective layer.

2. A. bone in your leg
   B. muscle in your arm
   C. nerve in your toe
   D. blood in your heart
   E. skin on your head

3. Unicellular organisms cannot grow to be very large. Most unicellular organisms must live in moist, food-rich environments.

4. Three advantages of being multicellular are the following:

   - Multicellular organisms can live in a wide variety of environments.
   - They can become very large.
   - Multicellular organisms can get energy from a wide variety of food sources.

5. **a.** The four levels are cells, tissues, organs, and organ systems.
   b. The organism could be thought of as the fifth level of organization.
   c. The organelle could be added.

6. Your table should be similar to the following one.

Tissue List		
Tissue	**Type of Tissue**	**Function**
epidermal (skin)	**plant**	**protects outside of plant**
xylem	**plant**	**transports water from roots**
phloem	**plant**	**transports food—sugar—from leaves**
muscle	**animal**	**moves body parts**
nerve	**animal**	**carries signals between brain and other body parts to co-ordinate activities**
epithelial (skin)	**animal**	**protects outside of body and covers internal structures like the intestines**
connective	**animal**	**connects and supports different parts of the body—may be solid (bone), fluid (blood), or loose, fibrous sheets**

7. Answers may vary. Examples of animal and plant organs are the following.

   - animal—stomach, lungs, heart, kidneys, liver, brain, skin, eye, ear
   - plant—roots, stems, leaves, stamen, ovaries

8. The systems found in plants are these:

   - the root system
   - the shoot system—stems and leaves
   - the reproductive system—flowers, fruits, and seeds

9. Textbook step 2 from "Procedure," page 142:

You could complete step 2 by using a chart like the following one.

Photos	Identification	Sample Reason
A	**skeletal muscle tissue**	**There are light and dark bands visible, like the muscle tissue shown in Figure B on page 139 of the textbook.**
B	**bone tissue**	**There seems to be connective tissue around the cells.**
C	**nerve tissue**	**The cell has a fibrous appearance.**

10. Textbook questions 1 and 2 from "What Did You Find Out?" on page 142:

1. Answers will vary. The network makes nerve cells easy to identify.

2. Answers will vary. Doctors, nurses, pathologists, and coroners are among possible careers.

The ways information can be used will vary. For example, a pathologist looks for abnormalities in tissues that may result in disease.

11. Textbook question 4 from "Topic 5 Review," page 144:

4. **(a)** A tissue is made from groups of *cells*.
(b) Muscle is an example of *a tissue*.
(c) The heart is an example of *an organ*.
(d) One example of connective tissue is *bone tissue*.
(e) An example of a system in plants is *the shoot system*.
(f) The type of tissue that protects the outside of a plant is called *epidermal tissue*.

Section 2: Review

1. selectively permeable
2. specialized
3. related
4. tissues; organs; organ systems
5. levels of organization
6. root; shoot; reproductive
7. vascular; xylem; phloem
8. Transpiration
9. plant food
10. water and minerals
11. root hairs
12. water
13. permeable
14. impermeable
15. Diffusion

Section 3: Lesson 1

1. **a.** C **d.** B
   b. C **e.** A
   c. B

2. **Textbook steps from "Procedure," page 147:**

   People's resting heart rates vary. Suppose you counted 19 beats in 15 s. Then your heart rate is $19 \times 4 = 76$ beats per minute.

   After the knee bends, your heart rate increases—the amount of the increase depends on your fitness. Suppose you counted 24 beats in 15 s after the knee bends. That indicates a heart rate of $24 \times 4 = 96$ beats per minute.

3. Jumping is a more strenuous activity than bending your knees. Jumping should increase your pulse rate even more. The increase varies from person to person. Suppose you counted 28 beats in 15 s after jumping. Then your heart rate would be $28 \times 4 = 112$ beats per minute.

4. **Textbook question from "What Did You Find Out?" on page 147:**

   The relationship between pulse rate and exercise is this: The more strenuous the exercise, the greater the pulse rate.
   Explanation: The more strenuous the exercise, the more food and oxygen must be supplied by the blood to the muscles. To supply more food and oxygen, the blood must flow faster. To make the blood flow faster, the heart must beat faster.

5. The capillaries of the circulatory system meet with the alveoli of the lungs.

6. They are similar in the following ways:

   - Both have very thin walls.
   - Both have many capillaries near their surfaces.
   - Both are tiny projections and there are huge numbers of them. (This greatly increases the surface area that is in contact with the capillaries.)

7. **a.** The flow diagram should include the following information.

   atmosphere → nose → trachea → bronchus → bronchiole → alveolus → capillaries → vein from lungs to heart → left atrium → left ventricle → aorta → arteries → capillaries → villi

   Note: The vein from the lungs to the heart is the only vein that carries oxygenated blood. This vein is called the pulmonary vein.

b. Your flowchart should be boxed in the following groups.

respiratory system:
atmosphere → nose → trachea → bronchus → bronchiole → alveolus

circulatory system:
capillaries → vein from lung to heart → left atrium → left ventricle → aorta → arteries → capillaries

digestive system:
villi

c. The path of waste carbon dioxide is mostly opposite to that of oxygen.

villi → capillaries → veins → vena cava → right atrium → right ventricle → artery from heart to lungs → capillaries → alveolus → bronchiole → bronchus → trachea → nose → atmosphere

Note: The artery from the heart to the lungs is the only artery carrying poorly oxygenated blood. This artery is called the pulmonary artery.

8. A "dive reflex" similar to the one that takes place in seals, slows the child's metabolism and decreases blood flow to the child's extremities—this lowers the need for oxygen.

10. Your nervous system monitors external temperatures through temperature receptors in the skin.

11. Textbook questions 1 and 2 from "What Did You Find Out?" on page 152:

1. The thigh muscles contract to produce the knee-jerk reaction.

2. The diagram should indicate the following information:
tap (stimulus) on tendon → nerve impulse to spinal cord → nerve impulse to thigh muscle (the feedback) → thigh muscle contracts and lifts leg

12. Textbook questions 1, 3, and 5 from "Topic 6 Review," page 153:

1. Every cell needs oxygen (and food) to give it energy. The energy-releasing process is called respiration.

3. False. Lung tissue contains no muscle cells. The diaphragm and ribs move to cause a change in the size of the chest cavity. Air pressure in the chest changes relative to atmospheric pressure. The lungs expand and contract passively as a result of these changes.

5. Shivering when you are cold involves muscles contracting and expanding repeatedly. This activity makes thermal energy. The thermal energy makes you warm again.

13. Frederick Banting and Charles Best discovered insulin.

Section 3: Lesson 2

1. An amoeba is made up of one cell. This one cell is in direct contact with its environment. This allows the cell to easily get rid of wastes and take in water and nutrients.

   In contrast, a human is multicellular. Therefore, there are cells inside the body that are not in direct contact with the external environment. These cells must have wastes transported away from them and nutrients transported to them. The circulatory system provides this necessary transportation.

2. Factors include

   - smoking
   - high blood pressure
   - a poor diet
   - a high-fat diet
   - high blood cholesterol
   - a lack of exercise
   - a high-salt diet

3. **Textbook question 3 from "Topic 7 Review," page 162:**

   3. The three main types of food are carbohydrates, fats, and proteins.

   Carbohydrates provide the main source of energy, while fats provide energy and cushioning for organs. Protein provides the building blocks of material needed for growth and tissue repair.

4. A low-fibre diet can harm your health for the following reasons:

   - A low-fibre diet can lead to colon irritation and eventually cancer because it increases the time waste material spends in the colon.

   - A low-fibre diet can result in hard feces, which may become trapped in the appendix and cause appendicitis.

5. **Textbook question 5 from "Topic 7 Review," page 162:**

   5. People from rural India typically eat a high-fibre, low-fat, low-sugar diet. In Canada, their diet often changes to more of a low-fibre, high-fat, high-sugar diet. These changes can lead to an increase in the incidence of colon cancer.

6. **a.** Cilia traps and removes dirt and bacteria.

   b. Cigarette smoking and pollutants irritate the lining of the lungs by causing the mucous-producing cells to produce more mucous. The lining can then become inflamed, which may lead to a condition called bronchitis.

   c. Exposure to cigarette smoke and other pollutants can cause emphysema and lung cancer.

9. The items should be sorted into the following categories.

Lifestyle Choices and Health	
Unhealthy	**Healthy**
ignoring health problems **excessive stress** **smoking** **eating only very low-fat food**	**washing your hands regularly** **being physically active** **getting plenty of sleep**

10. Essentials are clean air and water, nutritious foods, exercise, and sleep.

Section 3: Review

1. **a.** digestive system; villi
b. respiratory system; carbon dioxide
c. circulatory system
d. excretory system
e. nervous system; endocrine system
f. alveoli
g. Capillaries
h. sense
i. plasma
j. hypertension
k. heart attacks
l. strokes
m. heart rate
n. high; low
o. lifestyle

2. **Textbook questions 2, 4, 5, and 8 from "Wrap-up: Topics 6 and 7," page 163:**

2. **(a)** The *circulatory* system transports dissolved food particles and oxygen.

(b) Your body's responses to stimuli are co-ordinated by the *nervous and/or endocrine systems*.

4. **(a)** The excretory system regulates blood composition and gets rid of waste fluids.

(b) The respiratory system exchanges oxygen and carbon dioxide.

5. Red blood cells carry the large quantities of oxygen that are necessary to sustain life functions.

8. A high-fat diet can lead to hypertension, strokes, and heart attacks as cholesterol builds up on the inside of blood vessels.

Module Review

1. Answers will vary. Examples are provided. The words in italics are the variables.

a. How does the *amount of sugar* dissolved in water (MV) affect the *population density* of micro-organisms in the water (RV)?

b. How does the *diffusion rate* (RV) change with the *distance* the solute particles have to travel (MV)?

How does the *height* of a graduated cylinder holding a solvent (MV) affect the *time* needed for the solute to diffuse throughout the solvent (RV)?

2. The microscope parts and functions match as follows.

a. D
b. A
c. C

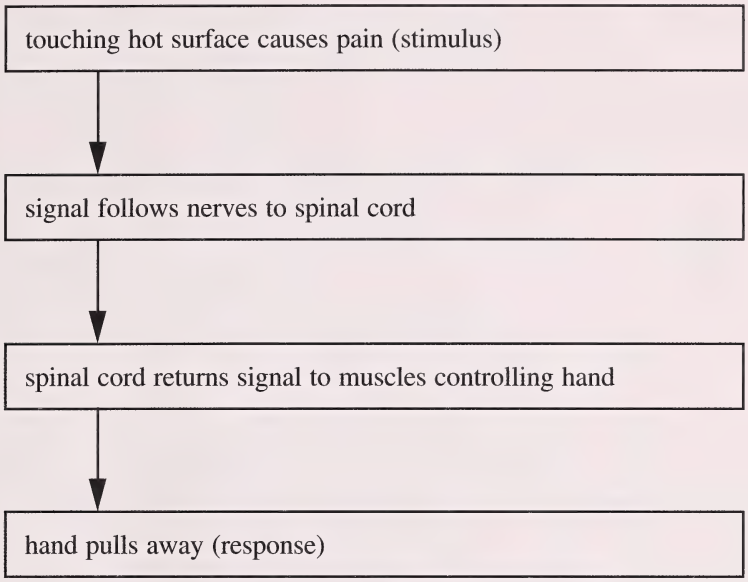
3. The following are some possible answers:

- The heart pumps blood.
- Lungs exchange gases.
- Kidneys remove wastes from the blood.
- The skin controls body temperature and excretes wastes. It also protects against bacteria, viruses, and mechanical wear, and it provides support.
- The stomach chemically and mechanically breaks down food.

4. Here are some ways you can promote the health of your organs:

- Get plenty of sleep.
- Exercise regularly.
- Eat a well-balanced diet.
- Don't smoke.
- Avoid air pollution and industrial by-products.
- Drink lots of clean water.

5. The following illustrates what happens when your finger touches a hot frying pan.


touching hot surface causes pain (stimulus)
signal follows nerves to spinal cord
spinal cord returns signal to muscles controlling hand
hand pulls away (response)

6. Yes, plant cells must respire because they also need energy. The process of photosynthesis turns light energy into sugar. The plant cells use the sugar during respiration as a source of usable energy.

7. Both diffusion and osmosis involve the movement of particles through the spaces in a fluid from an area of higher concentration to an area of lower concentration. Osmosis, however, refers to a special kind of diffusion—the movement of water through a selectively permeable membrane.

8. Both villi and alveoli have very large surface areas, single-cell walls, and a net of capillaries.

9. Three body systems harmed by smoking are the digestive, respiratory, and circulatory systems.

Smoking promotes peptic ulcers in the digestive system.

In the respiratory system, smoking damages and destroys cilia—this leads to bronchitis, emphysema, and cancer.

Smoking causes blood vessels to constrict in the circulatory system—this increases the blood pressure level and the heart rate. Smoking also decreases oxygen content in the blood because carbon monoxide from smoke attaches to red blood cells. With carbon monoxide attached, red blood cells cannot carry as much oxygen.

10. Living things

- are made up of cells
- require energy
- grow
- sense and respond
- produce wastes
- reproduce

11. The letters match as follows.

a. B
b. A
c. C

Note: Arteries, veins, and capillaries are all blood vessels. They differ in size and wall thickness. Veins have valves and carry blood to the heart. Arteries have muscular walls and carry blood away from the heart. Capillaries are the exchange sites between the blood and other cells.

12. Organelles are microscopic structures that perform their functions in single cells. Organs are large structures composed of more than one type of tissue. Organs are found in multicellular organisms.

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